DOE/NASA CONTRACTOR REPORT

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SOLAR HEATING SYSTEM INSTALLED AT STAMFORD, CONNECTICUT - FINAL REPORT

Prepared by

Lutz-Sotire Partnership
992 High Ridge Road
Stamford, Connecticut 06905

Under Contract DOE-EX-76-C-01-2377 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy

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16. ABSTRACT

This document provides information on the solar heating system installed at the Lutz-Sotire Partnership Executive East Office Building, Stamford, Connecticut. The information consists of description of system and components, operation and maintenance manual, as-built drawings and manufacturer's component data.

The solar system was designed to provide approximately 50 percent of the heating requirements. The solar facility has 2,561 sq. ft. of liquid flat plate collectors and a 6000 gallon, stone lined, well-insulated storage tank. Freeze protection is provided by a 50 percent glycol/water mixture in the collector loop. From the storage tank, solar heated water is fed into the building's distributed heat pump loop via a modulating three-way valve. If the storage tank temperature drops below 80°F, the building loop may be supplied from the existing electrical hot water boilers.

The Executive East Office Building is of moderate size, 25,000 sq. ft. of heated space in 2 1/2 stories. The solar system makes available for other users up to 150 KVA of existing electrical generating capacity.

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PRINCIPLES OF OPERATION

The Executive East Office Building in Stamford, Connecticut, is of moderate size, 25,000 square feet of heated space in 2½ stories. It utilizes aluminum and glass curtain wall construction, typical of office buildings built prior to the energy crisis. It is located next to a major shopping center on a busy highway in Stamford, providing for high visibility. The building is oriented with the long axis pointing 5° west of south. The roof is flat and almost completely unobstructed. Present zoning regulations prevent any high buildings from being erected which might intercept the sunshine to the building.

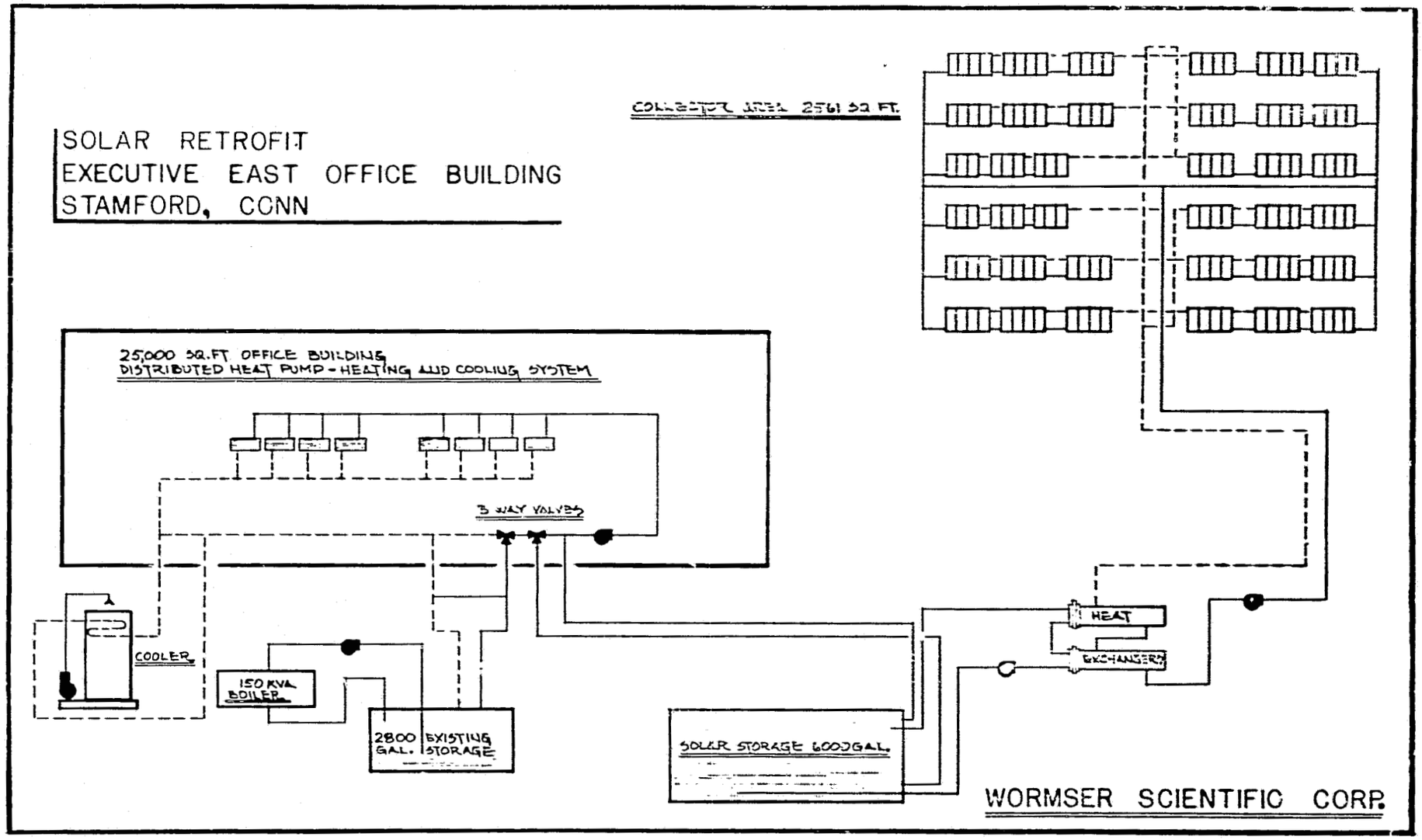
The building utilizes a highly efficient heating and cooling system. A series of nearly 80 water-source heat pumps provide heating and cooling throughout the building, as shown in Figure 1. They are connected in series in a building hydronic loop, which is always maintained between 75 and 85°F. When a heat pump is heating, it adds heat to the building, while extracting heat from the hydronic loop. When there is a preponderance of heating in the building, heat has to be added to maintain temperature in the hydronic loop between 75 and 85°F. Prior to installation of the solar system, all heat was supplied to the hydronic loop by two 75 KVA electric boilers.

The distributed heat pump heating system with its 150 KVA electrical boiler backup system, together with a nearly completely empty, flat roof, which faces nearly due south-made the building a very attractive candidate for a solar retrofit project.

The solar system installed on the building replaces more than half the total electrical energy previously used for heating throughout the year, and eliminates all the electrical boiler capacity used during peak daytime generating hours. It thus makes available for other users in Southern Connecticut up to 150 KVA of existing electrical generating capacity.

The solar system fully utilizes the available roof space. Six rows of liquid flat plate solar collectors or a total of 138 collectors are equally spaced along the 130 foot length of the building. These collectors have an effective

FIGURE 1



FLOW DIAGRAM

area of 2,561 square feet. Hinged, polished, anodized aluminum reflectors, Figure 2, page B6, equal in length to the collectors are mounted in front of each row of collectors. These collectors increase the energy input into the solar system by 46 percent during the winter months when maximum heating is required for the building, Figure 3, page B7.

The collector/reflector ray diagram, shown in Figure 3, demonstrates the month-by-month added gain due to the addition of the reflector system. The numbers in degrees, shown in Figure 3, represent the noon sun deviation month-by-month. The varying collector/reflector lengths (month by month) represent the effective aperture of the collector/reflector assembly as a function of the month-by-month sun angle.

During the preliminary test period in the month of September, the reflectors were estimated to add between 20 and 30 percent to the solar energy input into the building.

Reflectors are hinged and fold up easily to form a protective shield for the solar collectors. This is extremely useful to protect the collectors from overheat or stagnation conditions when they are not in use during the summer months. The protective shutters may also be used to limit the solar input to the building when the heating requirements of the building are small.

A mixture of water and 50 percent ethylene glycol is circulated through the collectors. Reverse return piping is used, and balancing valves are inserted after each block of four collectors to provide equal distribution of flow throughout the 138 collectors. The flow through the 138 collectors has been designed and regulated to be 138 gallons per minute, or 1.0 gpm per collector. The solar collector fluid is passed through one side of a two-section shell-and-tube heat exchanger. The solar loop circulating pump is actuated by an adjustable differential thermostat, which is set to turn on when the collector temperature rises to $20^{\circ}F$ above the tank temperature and shut off when the differential drops below $5^{\circ}F$. This achieves maximum energy transfer without excessive on-off cycling by the pump.

On a sunny winter day, the collector/reflector array delivers 2.6×10^6 BTU's through the heat exchanger to the storage,

raising the storage tank temperature as much as 50°F when there is no daytime heat load. The two-section heat exchanger has been designed for minimum temperature drop. Energy is delivered to a 6,000-gallon, stone lined, well-insulated storage tank.

From the solar storage tank, solar heated water is fed into the building's distributed heat pump loop via a modulating three-way valve. If the storage tank temperature drops below 80°F, the building loop may be supplied from the existing electrical hot water boilers. The solar system is estimated to provide more than 50 percent of the average heating demand of the building, and operation of the existing electrical boiler system is confined to off-peak demand hours.

Maximum storage capability for the 6,000-gallon tank was calculated at 5.8×10^6 BTU's which occurs for a temperature increase of 120°F above 85°F, or 205°F. In actual practice it has been found, with the present control configuration, that the storage tank reaches a maximum temperature of 185°F after three sunny days without heat load.

DESCRIPTION OF COMPONENTS

Collector System

The collector-reflector array is mounted on a Corten weathering steel support structure which is maintenance free. Steel dunnage was mounted on the roof and connected to the vertical steel members of the building. Triangular steel trusses to support up to 12 collector and matching reflectors were designed and prefabricated. After the roof was suitably prepared including the installation of a new roof surface to permit the increased activity, the prefabricated collector-reflector mounts were hoisted onto the roof surface and welded in place. This procedure required only two days. The 138 Sunworks flat plate collectors were delivered and raised to the roof surface in a single day. Collectors were installed in rows of 12 and in subgroups of four. An expansion compensator and a flow regulating valve were installed after each group of four.

A certain amount of difficulty was encountered due to the lack of uniform high quality control standards in the fabrication of the collectors. The type of collector used has an internal manifold which terminates in a pipe swaged to received a one-inch diameter and one-inch long connecting pipe nipple, which is solder connected using 95-5 solder. The swaging of the collector pipe manifold endings was non-uniform which made the soldering of the collector pipe connections difficult.

The Sunworks flat plate absorbers trademarked Solectors are fabricated by oven brazing 3/8" O.D. copper tubes to a .010" thick copper sheet, using zinc chloride flux. On many of the 138 collectors initially delivered, excess flux oozed out from the brazed joints when the collectors were heated to stagnation temperatures, resulting in discoloring of small sections of the selectively blackened absorber surfaces. The collectors showing this problem were replaced.

The exterior dimensions of the flat plate collector assembly are 7'-0" long by 2'-11½" wide, with a thickness of 4". The weight of a single glazed collector is 110 lbs. dry, 114 lbs. with fluid, or 5.50 lbs per square foot.

The aperture or net glass area per panel is 18.88 square feet with the net absorber area per panel totaling 18.50 square feet. The ratio of usable absorber area to the total surface

covered equals 0.89.

The absorber used consists of a copper sheet 0.01" thick with a proprietary cooper oxide selective black surface manufactured by Enthone, Inc. The absorber has an absorptivity with a minimum of .87/.92, and an emissivity with a maximum of .07/.35. The maximum allowable temperature for the absorber is above 400°F.

The tubes within the absorber consist of ½" I.D. (0.375" O.D.) Type "L" copper spaced 4" O.C., and are patterned in a grid vertical to the manifold. Soft solder is used to connect the tubes to the sheet, while a brazing alloy connects the tubes to the manifold. Connections to external piping are 1" nominal X 1-3/8" with long nipple type "M" copper extending 0.31" beyond (See diagram, Figure 4, page B10).

For additional information on Collector System see appendix B, page B 9.

Circuit Balancing Valves

Circuit setters are Bell & Gossett Model CB. One (1) B&G #RO-4 differential meter was used to adjust all circuits to the design flows. After final adjustments, this meter will be turned over to the Owner.

Thermal Storage Tank see Appendix B., page B 11.

Piping and Joints see appendix B, page B 12.

Pipe Sleeves see appendix B, page B 12.

Hangers see appendix B, page B 12.

Valves see appendix B, page B 12.

Hot Water Specialties see appendix B, page B 12.

Pressure Gauges see appendix B, page B 13.

Thermometers see appendix B, page B 13.

Blackflow Preventer see appendix B, page B 13.

Chemical Treatment see appendix B, page B 13.

Low Water Control see appendix B, page B 13.

Roofing

A new roof was applied to the building prior to the attachment of the solar collectors. The existing roof and insulation was removed down to the steel deck. All loose flashing was removed and membrane flashing was installed at the base of ventilators, skuttle, mechanical equipment, and the outside perimeter. New roof drains were installed and connected to the existing drain. New lead flashings were installed at roof drains. The existing fascia was capped, new copper pitch boxes and new copper roof vent boots installed.

For additional information on Roofing see appendix B, page B 29.

Tests - see appendix B, page B 14.

Pumps - see appendix B, page B 14.

Heat Exchangers - see appendix B, page B 23.

Insulation - see appendix B, page B 29.

Controls - see appendix B, page B 30.

Electrical - see appendix B, page B 31.

APPENDIX A

Acceptance Test Plan for Solar Heating System, Executive East Office Building, 1011 High Ridge Road, Stamford, Connecticut

The test is designed to demonstrate that the solar heating system operates in accordance with the design specifications. The acceptance test shall be made prior to putting the solar heating system into regular operation.

A. Items to be Tested

The items to be tested will include all parts of the operating and control systems. Specifically, the plumbing system, the pumps, the control transducers, the control actuators, and the system safety and warning components will be tested.

B. Test Objectives

The objectives of the test program are to determine and demonstrate that the system is functionally operable, that it meets the design specifications, and that it is safe for use.

C. Test Requirements

Test requirements to be met prior to start of operation are as follows:

1. All plumbing system components, including piping and fittings, solar collectors, storage tanks, and heat exchangers, shall be tested in the system to at least 150 percent of design working pressures. Leaks, if any, shall be made tight, and retests performed until no discernible leaks are found.

2. Flow rates shall be determined throughout the system under all modes of operation to determine that pumps are delivering design fluid flows, and that obstructions are not present in the system, and circuit setters are set so as to deliver the proper flow rates to all parts of the system. Particular

attention shall be paid to obtaining uniform flow throughout the collector array.

3. All of the operational modes outlined under the Control System Description shall be exercised and the proper function of all control devices and associated control valves shall be verified.

4. Safety components such as electrical circuit breakers, over pressure relief valves and like components shall be tested to provide safety relief at the proper setting.

D. Operational Test Requirements

1. Once the pre-operational tests outlined above are successfully completed, the system operation shall be started.

2. Utilizing the GFE instrumentation and monitoring system, which should be provided with a real time local readout facility, the operation of the system and the subsystems from an energy gathering and transfer point of view will be monitored and compared to the system performance predictions.

In particular, the following quantities will be monitored and computed at intervals of 15 minutes, one hour, and per each day.

a. Incident solar radiation

b. Energy absorbed for a given moment of incident solar energy and delivered by the solar collector array to the heat exchanger.

c. Energy delivered from the heat exchanger to the 6,000-gallon storage tank.

d. Temperature history of the 6,000-gallon storage tank.

e. Energy delivered from the 6,000-gallon storage tank to the building closed loop.

f. Energy generated by the auxiliary electric boilers and delivered to the 2,800-gallon storage tank.

g. Energy delivered from the 2,800-gallon auxiliary storage tank to the building closed loop.

h. Total energy delivered to building from all sources as a function of difference between inside ambient temperature and outside ambient temperature.

APPENDIX B

OPERATION AND MAINTENANCE MANUAL

CONTRACT EX-76-C-01-2377

EXECUTIVE EAST SOLAR SYSTEM
1011 High Ridge Road
Stamford, CT 06905

Prepared by:

Wormser Scientific Corporation
88 Foxwood Road
Stamford, CT 06903

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SYSTEM DESCRIPTION

The Executive East Office Building in Stamford, Connecticut, is of moderate size, 25,000 square feet of heated space in 2 1/2 stories. It utilizes aluminum and glass curtain wall construction, typical of office buildings built prior to the energy crisis. It is located next to a major shopping center of a busy highway in Stamford, providing for high visibility. The building is oriented with the long axis pointing 5° west of south. The roof is flat and almost completely unobstructed. Present zoning regulations prevent any high buildings from being erected which might intercept the sunshine to the building.

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The distributed heat pump heating system with its 150 KVA electrical boiler backup system, together with a nearly completely empty, flat roof, which faces nearly due south, made the building a very attractive candidate for a solar retrofit project.

The solar system installed on the building replaces more than half the total electrical energy previously used for heating throughout the year, and eliminates all the electrical boiler capacity used during peak daytime generating hours. It thus makes available for other users in Southern Connecticut up to 150 KVA of existing electrical generating capacity.

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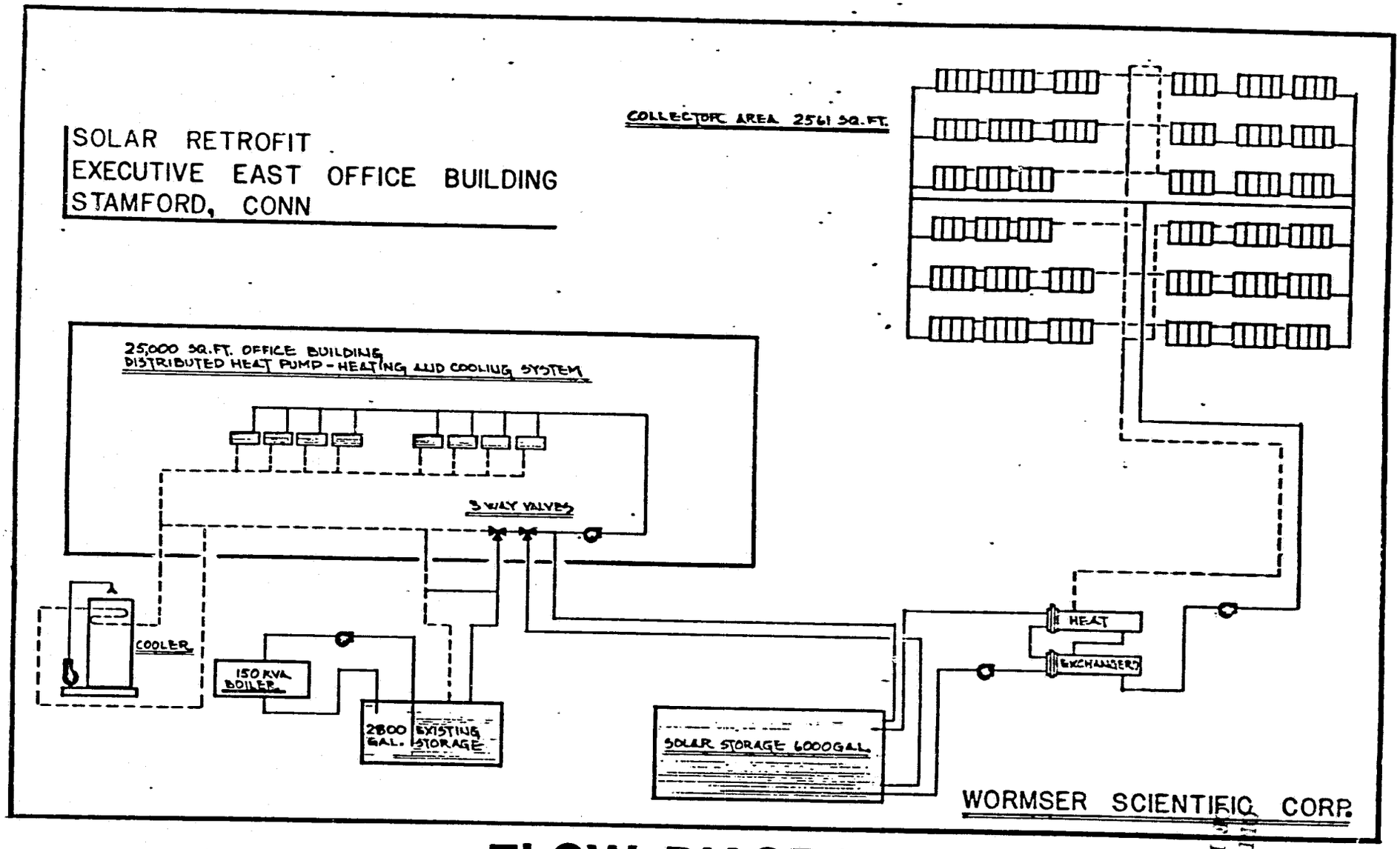
Reflectors are hinged and fold up easily to form a protective shield for the solar collectors. This is useful to protect the collectors from overheat and stagnation conditions when they are not in use during the summer months. The protective shutters may also be used to limit the solar input to the building when the heating requirements of the building are small.

FIGURE 1



FLOW DIAGRAM

Month	Without Reflector	With Reflector	% Added	80% Ref.
Dec.	6.89	9.22	34	27
Jan-Nov	6.87	9.62	40	32
Feb-Oct	6.92	10.92	58	46
Mar-Sept	6.75	9.55	41	33
Apr-Aug	6.25	7.88	26	21
May-July	5.66	6.16	08	06
June	5.50	5.50	0	0

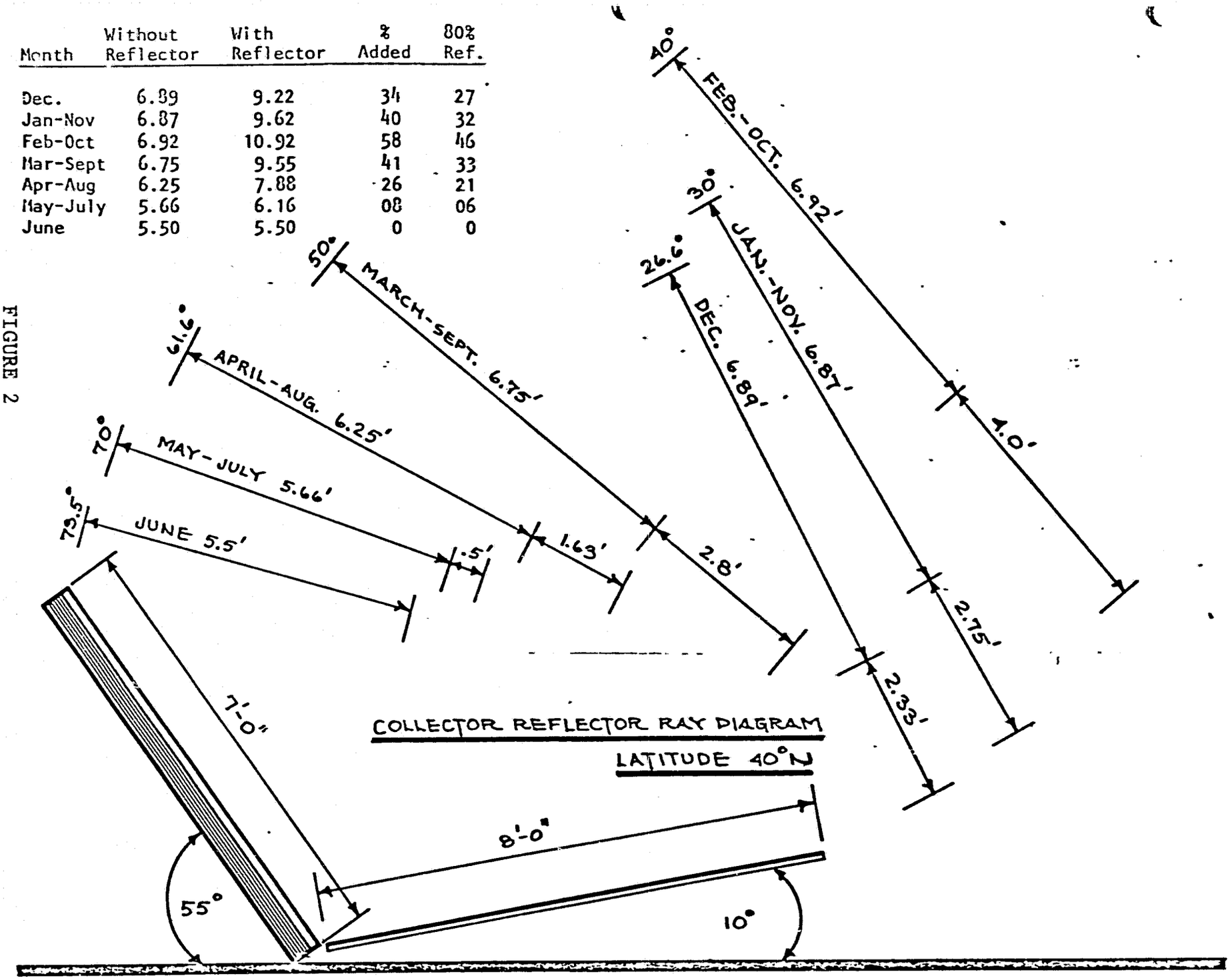
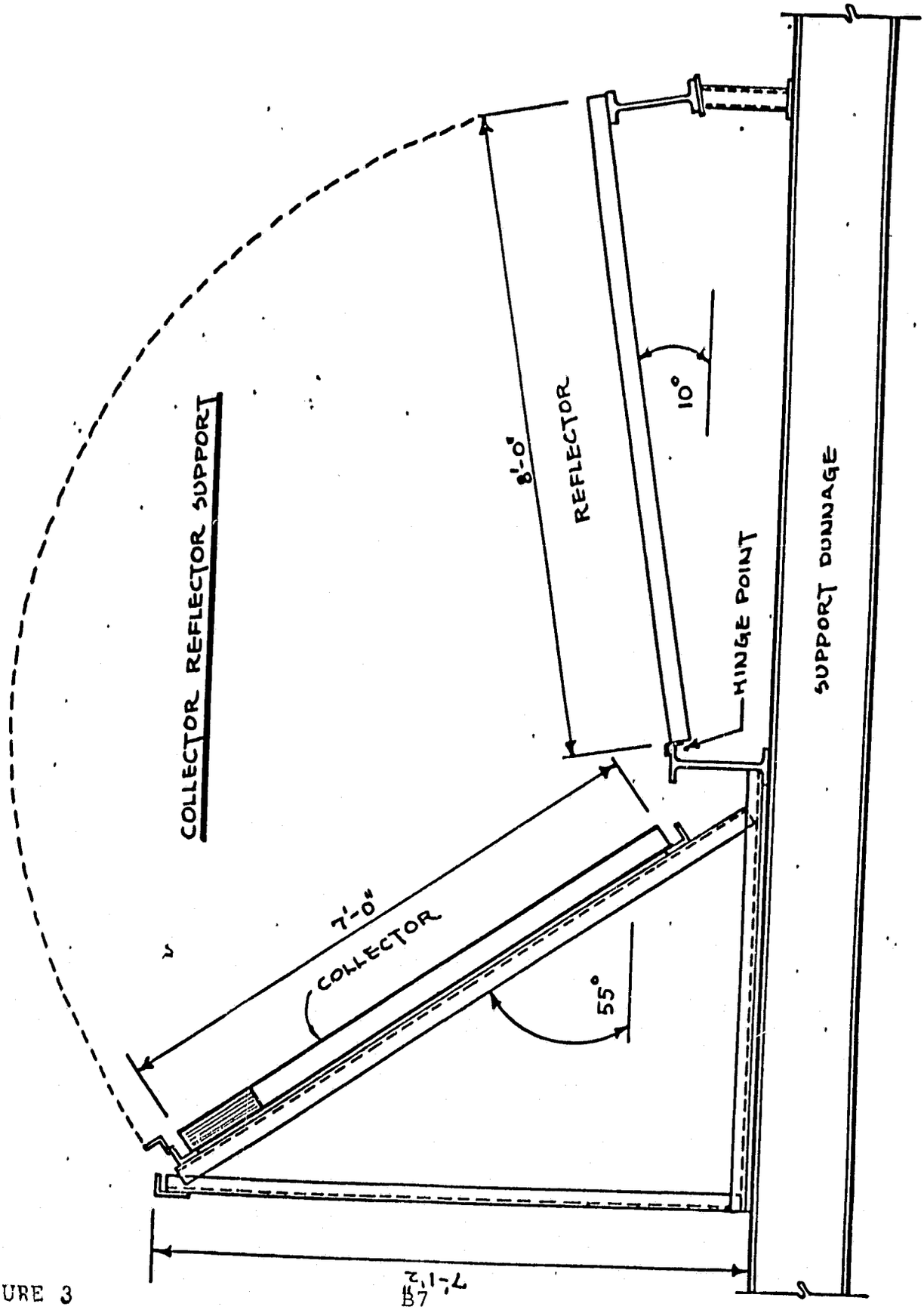


FIGURE 2



SECTION

FIGURE 3

FIGURE 3

A mixture of water and 50 percent ethylene glycol is circulated through the collectors. Reverse return piping is used, and balancing valves are inserted after each block of four collectors to provide equal distribution of flow throughout the 138 collectors. The flow through the 138 collectors has been designed and regulated to be 138 gallons per minute, or 1.0 gpm per collector. The solar collector fluid is passed through one side of a two-section shell-and-tube heat exchanger. The solar loop circulating pump is actuated by an adjustable differential thermostat, which is set to turn on when the collector temperature rises to 20°F above the tank temperature and shut off when the differential drops below 5°F. This achieves maximum energy transfer without excessive on-off cycling by the pump.

On a sunny, winter day, the collector-reflector array delivers 2.6×10^6 BTU's through the heat exchanger to the storage, raising the storage tank temperature as much as 50°F when there is no daytime heat load. The two-section heat exchanger has been designed for minimum temperature drop. Energy is delivered to a 6,000-gallon, stone-lined, well-insulated storage tank.

From the solar storage tank, solar heated water is fed into the building's distributed heat pump loop via a modulating three-way valve. If the storage tank temperature drops below 80°F, the building loop may be supplied from the existing electrical hot water boilers. The solar system is estimated to provide more than 50 percnet of the average heating demand of the building, and operation of the existing electrical boiler system is confined to off-peak demand hours.

Maximum storage capability for the 6,000-gallon tank was calculated at 5.8×10^6 BTU's, which occurs for a temperature increase of 120°F above 85°F, or 205°F. In actual practice, it has been found, with the present control configuration, that the storage tank reaches a maximum temperature of 185°F after three sunny days without heat load.

COMPONENTS

Collector and Reflector System:

The collector-reflector array is mounted on a Corten weathering steel support structure which is maintenance-free. Collectors were installed in rows of 12, and in subgroups of four. An expansion compensator and a flow regulating valve were installed after each group of four.

The Sunworks flat plate absorbers trademarked Solectors are fabricated by oven brazing 3/8" O.D. copper tubes to a .010" thick copper sheet, using zinc chloride flux.

The exterior dimensions of the flat plate collector assembly are 7'-0" long by 2'-11 1/2" wide, with a thickness of 4". The weight of a single glazed collector is 110 lbs. dry, 114 lbs. with fluid, or 5.50 lbs per square foot.

The aperture or net glass area per panel is 18.88 square feet with the net absorber area per panel totaling 18.50 square feet. The ratio of usable absorber area to the total surface covered equals 0.89.

The absorber used consists of a copper sheet 0.01" thick with a proprietary copper oxide selective black surface manufactured by Enthone, Inc. The absorber has an absorptivity with a minimum of .87/.92, and an emissivity with a maximum of .07/.35. The maximum allowable temperature for the absorber is above 400°F.

The tubes within the absorber consist of 1/4" I.D. (0.375" O.D.) Type "L" copper spaced 4" O.C., and are patterned in a grid vertical to the manifold. Soft solder is used to connect the tubes to the sheet, while a brazing alloy connects the tubes to the manifold. Connections to external piping are 1" nominal X 1 3/8" with long nipple type "M" copper extending 0.31" beyond (See diagram, Figure 4).

The copper tubing and their connections inside the Solector are guaranteed by the manufacturer against leaks for five (5) years commencing on Sept. 28, 1978. A five-year materials and workmanship guarantee also covers all parts of the Solector excepting cover glazing. The selective surfaces are guaranteed to retain 80 percent or more of their initial collector efficiency for a period of five (5) years after date of purchase for single glazed collectors. This guarantee is contingent upon the following conditions:

1. Surface is kept clean and free of dirt and dust.

2. Collector enclosures are watertight, and defective glass covers are promptly replaced to prevent direct exposure of the selective surfaces.

3. The level of sulfur dioxide and other pollutants are within the levels specified by EPA regulations.

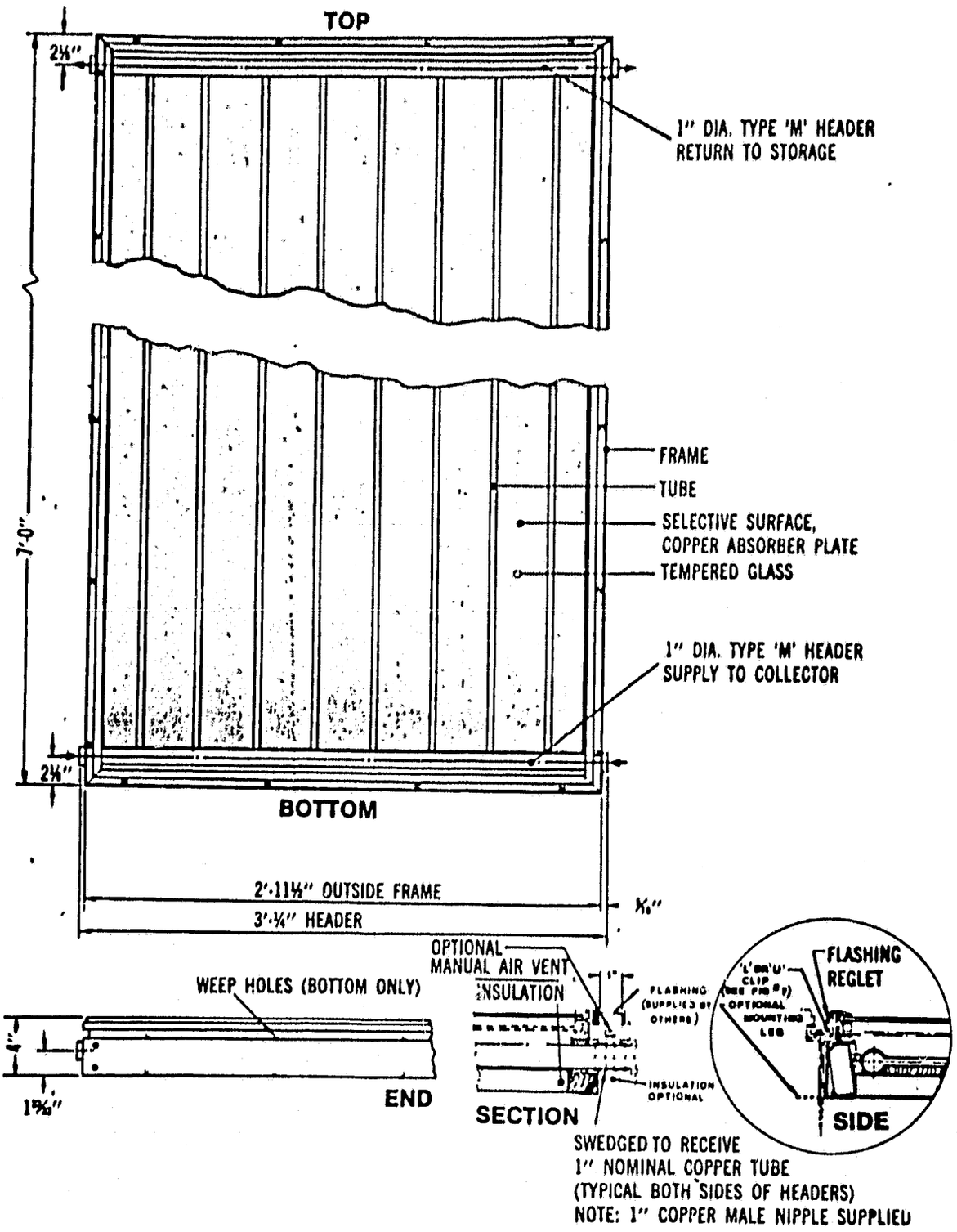


FIGURE 4

Any panels found to be defective during the warwantee period will be repaired or replaced by Sunworks at no additional cost to the Owner.

Since the reflectors are hinged and equal in size to the collectors, they can be conveniently closed to act as shutters for the flat plate collectors. This protects the collectors from stagnation conditions in the summer months when the solar heating system is not used. It also permits shuttering a portion of the flat plate collector array to permit matching solar input and heat load requirements in the spring and fall, and thus avoids overheating of the storage in the transition periods.

Solar reflectors are made of King-Lux pre-anodized high purity aluminum sheet or coil in a guage of .012 inches as distribured by Kingston Industries Inc. Reflector sheet performance meets or exceeds absolute hemispherical spectral reflectance measurements of aluminum (specular 87.4%), as performed by Desert Sunshine Exposure Tests, Inc. DSET Order NO. 171275 of March 4, 1977, for Kingston Industries Inc.

Reflector sheets were shop laminated by the Berry Metal Group of New Jersey. Adhesives used in the laminating process are of such composition as to insure against delamination of the high purity aluminum sheet from the basic support sheet (Galvalume) for a period of not less than five (5) years. For additional assurance, reflector sheets are riveted to the Galvalume support.

Solar reflectors were shop laminated to 22 gauge Galvalume sheet steel manufactured by Bethlehem Steel Corporation and conform to ASTM A446 or ASTM A661, having a minimum yield strenth of 35,000 PSI. The Galvalume sheet has a minimum coating weight of 0.5 oz. of aluminum-zinc alloy per square foot of coated sheet (both sides), equivalent to 0.8 mil thickness on each side. Performance, composition, and weathering characteristics are as set forth in Bethlehem Spec-Data Sheet for metals and alloys 5p, May, 1974, and Descriptive Sheet Folder 2799-A.

All fasteners penetrating the reflector and/or reflector support sheet are Series 306 alloy stainless steel.

Thermal Storage Tank:

The thermal storage tank is 6,000-gallons capacity, 8'-0" diameter x 16'-0" overall length, manufactured by Bethlehem Steel Corp. It has non-coded construction rated for 50 psi service. Material is 5/16" thickness, steel shell, with 3/8" thickness heads. Two 4" and two 3" flanged connections are located in the head, and there are four 3/4" double tapped couplings in the manhole cover. The manhole is 24" in diameter. One shop coat of rust resistant paint and one field coat of bitumastic #50 waterproofing was applied.

The interior of the tank was lined in field with a 5/8" thickness of cement.

PLUMBING

Piping and Joints:

All joints 3 inches and larger are welded. Branch connections are made with weldolets of butt, threaded or socket type manufactured by Bonney Forge Company, for all branches 1/2 main size or larger.

No direct welded connections are made to valves, apparatus, and associated equipment which are required to be removable for repair or replacement.

All soldered joints are made with 95-5 solder.

Hangers:

All horizontal piping is supported from the building structure by means of approved type hangers at the following intervals:

Iron Type:	2" and larger	10 feet
	1 1/4" & 1 1/2"	8 feet
	3/4" & 1"	8 feet
	1/2"	6 feet
Copper Type:	2 1/2" & Larger	8 feet
	1/2" to 2"	6 feet

Hangers for solar piping on roof are the adjustable band types. Hangers elsewhere in the project are either the adjustable band type or the clevis type.

Pipe Sleeves:

Sleeves through the exterior wall below grade are black steel pipe, furnished with a welded center flange buried in construction. Pipes are made watertight in sleeves with oakum packing and caulked lead joints on both sides of any wall.

Sleeves through floors are 20 gauge sheet metal.

Hot Water Specialties:

All main vents are hand operated and consist of an air chamber, air cock, and 1/4" copper drain tube to a suitable point of discharge. Compression tank and fittings are as manufactured by Bell and Gossett. Pressure reducing valves are 3/4" size, B&G. Triple duty valves and suction diffusers are as manufactured by Bell and Gossett Company.

Valves:

Jenkins, Fairbanks, Walworth, and Sarco valves were used.

For gate valves, 2 1/2" and smaller (200 psi water pressure limitation) split wedge type with screw-in bottom tap connectors were used.

(Jenkins Figure 1240). Gate valves 3" and larger employ 125# iron body, bronze mounts, solid wedge, outside screw and yoke construction with rising stem configuration (Jenkins Figure #651).

Valves within the solar collector array are foged bronze ball valves with Teflon seats (Jenkins Fig. #1101-TE). Balancing fittings within the solar collector array are Sarco No. 60.

Check valves 2 1/2" and smaller are 300# bronze horizontal swing type regrind bronze disc with solder ends (Jenkins Fig. 1222). 3" and larger check valves are 125# iron body bronze mounted horizontal swing type, regrind-renew bronze disc with flanged ends (Jenkins Fig. 624.).

Circuit setters are Bell and Gossett Model CB. One (1) B&G #RO-4 differential meter was used to adjust all circuits to the design flows.

Expansion Compensators:

One inch braided type hose expansion compensators were used. These were manufactured by Annaconda.

Pressure Gauges:

Pressure gauges for pump 4 1/2" diameter phosphur bronze, Bourdon Type 0 to 60 psi, syphon and 1/2" brass tee handle cock. These are installed at suction and discharge flanges of all pumps.

Thermometers:

9" scale, vari-angle pattern, brass separable socket are used (Marshalltown no. 91302 1/2). These are installed at the following locations; heat exchanger (solar) - inlet and outlet (3); heat exchanger (tank) - inlet and outlet (3); injector loop to building system - supply and return (2).

Backflow Preventer:

A Watts #900-3/4" backflow preventer was installed in the cold water fill line to the existing heating system.

Low Water Control:

A mercoil pressuretrol at the suction side of the solar pumps, P1 and P2, was installed. This is coupled to a 4" alarm bell for the low water alarm system.

Chemical Treatment:

Chemical treatment as recommended by the existing water treatment manufacturer (Olin) was provided to the water content of the 6,000-gallon storage tank at the time of filling.

Tests:

All water piping was given a hydrostatic test before being covered or closed in. Before the connection of accessories which are subject to damage by pressure, the system was completely filled with water, the air bled from all high spots and pockets, the pressure brought up to 125 psi, and the system sealed. The system was maintained at this pressure for a period of eight hours, during which time no pressure drop was noted.

Collector Loop Make Up:

System make up fluid to the closed collector loop array is accomplished manually through the use of a hand pump located in the existing mechanical room. All make up fluid quantities to the closed collector loop must be 50 percent glycol and 50 percent water.

The collector loop will only require make up fluid if a portion of the system is drained down for repair or in the event the glycol solution has degraded to the extent that replacement is necessary.

Pumps:

The collector pump circulator is a vertical split case centrifugal pump with iron case and bronze impeller. The impeller is the enclosed type dynamically balanced, keyed to the shaft and secured with a locknut.

Pump seal is the standard single mechanical seal with carbon seal ring and ceramic seat. A replaceable shaft sleeve has been furnished to cover the wetted area of the shaft under the seal or packing. The bearing frame assembly of the pump is fitted with regreasable ball bearings equivalent to electric motor bearing standards for quiet operation.

Pump and motor are mounted on a common baseplate of heavy structural steel design, with securely welded cross members and open grouting area. A flexible coupler, capable of absorbing torsional vibration, is employed between the pump and motor.

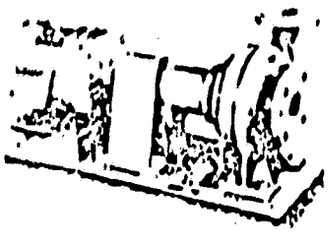
The pump was factory-tested, cleaned, and painted with one coat of machinery enamel prior to shipment. Pump is Bell and Gossett #1510-2BB, 5HP, 208 volt, 3 phase motor, rated at 110 GPM, at 70 ft. head. This pump is equipped with a magnetic starter with N.O. and N.C. contacts, H-O-A and pilot light in cover.

The heat exchanger circulator is a direct drive, iron body, bronze trimmed, centrifugal booster. Pump is Bell and Gossett PD-40, 1 1/2 HP, 3 phase, 208 volt motor, furnished with a magnetic starter with N.O. and N.C. contacts, H-O-A and pilot light in cover.

BELL & GOSSETT

INSTRUCTION SHEET

P81627



SERIES 1510 BASE MOUNTED CENTRIFUGAL PUMPS

INSTALLATION, OPERATION & SERVICE INSTRUCTIONS

LOCATION

Locate this pump so there is plenty of room for inspection, maintenance, and service. If the use of a hoist or tackle is needed, allow sufficient head-room.

We believe the best pump location for sound and vibration absorption is on concrete floor with sub soil underneath. If the pump location is overhead, special precautions should be undertaken to reduce possible sound transmission.

INSTALLATION

This pump is built to give you service . . . install it properly and provide a suitable foundation. A base of concrete weighing 2½ times the weight of the pump is recommended. (Check the shipping ticket for pump weight.)

If possible, tie the concrete pad in with the finished floor. Use foundation bolts and large pipe-sleeves to give room for final bolt location. (See Fig. 1.)

LEVELING

Place the pump on its concrete foundation supporting it with steel wedges or shims totaling 1" in thickness. These wedges or shims should be put on both sides of each anchor bolt to provide a means of leveling the base. (See Fig. 2)

IT IS VERY IMPORTANT THAT THE PUMP BASE BE SET LEVEL TO AVOID ANY MECHANICAL DIFFICULTIES WITH THE MOTOR OR PUMP. THIS PUMP WAS PROPERLY ALIGNED AND TEST-RUN AT THE FACTORY. HOWEVER, SINCE ALL PUMP BASES ARE FLEXIBLE THEY MAY SPRING AND TWIST DURING SHIPMENT. DON'T PIPE THE PUMP UNTIL IT IS REALIGNED AFTER PIPING IS COMPLETED AND AFTER THE PUMP IS GROUTED IN AND BOLTED DOWN. ALIGN IT AGAIN. IT MAY BE NECESSARY TO BE ADJUST THE ALIGNMENT FROM TIME TO TIME WHILE THE UNIT AND FOUNDATION ARE NEW.

GROUTING

After the pump has been leveled, securely bolted to the floor, and properly aligned, a good grade of grout should be installed around the pump base. A suggested mixture for grout is one part Portland Cement and two or three parts plain, sharp sand mixed with water until it will pour easily. Wet the concrete base before pouring grout. To hold wedges or shims in place, allow the grout to flow around them.

Important. Recheck alignment after grouting.

ROTATION

Rotation is clockwise when viewed from back of the motor. An arrow cast into the pump body shows the direction of rotation.

ALIGNMENT OF DISK-TYPE COUPLERS

To check pump and motor shaft alignment sufficient accuracy can be obtained by placing a straight edge across the coupling bodies after assembly. This will quickly indicate the amount of correction necessary to place the shafts in alignment. Maintain 1/8" clearance between the ends of the two (2) coupling halves. It may also be necessary to shift the pump or motor by loosening the base capscrews. Be sure to retighten these capscrews when alignment has been completed. Adjustments in one direction may alter alignment in another; hence, check alignment in all directions after a correction is made.

If couplings are to operate at speeds higher than 1800 RPM greater accuracy of shaft alignment will be required. This should be checked with a dial indicator.

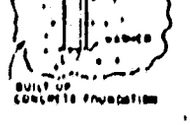


Fig. 1 Installation of foundation bolts

Fig. 2 Leveling of pump base on concrete foundation

PIPING

Be sure to eliminate any pipe strain on the pump. Support the suction and discharge pipes independently by use of pipe hangers near the pump. Line up the vertical and horizontal piping so that the bolt-holes in the pump flanges match the bolt holes in the pipe flanges. DO NOT ATTEMPT TO SPRING THE SUCTION OR DISCHARGE LINES INTO POSITION. Coupling and bearing wear will result if suction or discharge lines are forced into position. The code for Pressure Piping (A.S.A. B 31.1) lists many types of supports available for various applications.

As a rule, ordinary wire or band hangers are not adequate to maintain alignment. It is very important to provide a strong, rigid support for the suction line.

Where considerable temperature changes are anticipated, equipment for absorbing expansion should be installed in the system in such a way as to avoid strain on the pump.

On an open system with a suction lift, use a foot valve of equal or greater area than the pump suction piping. Prevent clogging by using a strainer at the suction inlet next to the foot-valve. The strainer should have an area three times that of the suction pipe with hole diameter of no less than ⅛".

A Bell & Gossett Triple Duty Valve installed in the discharge line will serve as a check valve to protect the pump from water hammer, as a gate valve for servicing and for throttling.

PRIMING AND STARTING

Open the gate valve in the suction line to allow the pump to fill with water, vent air from the pump body by unscrewing the top body plug. Turn the shaft a few times by hand to allow all trapped air to escape. Replace the vent plug.

Start the pump keeping the valve in the discharge line closed. Then open the valve gradually, pressure should start building up. If there is no buildup of pressure, the pump is not primed.

Note. Do not close or throttle the gate valve in the suction line while the pump is running. Do not prime the pump through the discharge pipe, this can result in pump damage.

BELL & GOSSETT TMD

LUBRICATION

Lubricate pump bearings at least twice a year or flush bearings whenever necessary with No. 2 mineral base petroleum grease while the pump is running. Lubricate motor bearings in accordance with the manufacturers instructions.

SERVICE INSTRUCTIONS:

1510 PF Stuffing Box (Packing With Flushing Tubing)

To replace packing loosen set screws in both coupler halfs and slide each half back as far as possible on its shaft. Where a full diameter impeller is used it will be necessary to remove the pump side coupler half and to slide the motor back on its base in order to gain sufficient clearance to remove the pump assembly from the volute. Remove support foot bolts and flushing tube. Next, remove capscrews holding the pump assembly to the volute and release using capscrews in jackscrew holes provided. Remove impeller. Then remove the capscrews holding the bearing assembly to the pump bracket and pull it free of the bracket and coverplate assembly. Remove packing gland and packing rings from the stuffing box. Check condition of shaft sleeve, replace if scored or otherwise damaged.

To assemble, insert two packing rings in the stuffing box followed by the lantern ring and remaining two pieces of packing. Make certain that the packing joints are staggered 90 degrees. Install but do not tighten the packing gland. Apply grease to the assembled packing and install over the pump shaft. Tighten packing gland to compress packing. Complete re-assembly by reversing removal instructions.

Caution: When returning the pump to service follow instructions on start-up tag carefully.

1510 P Stuffing Box (Packing Without Flushing Tubing)

To replace packing follow instructions as outlined for model 1510 PF.

Construction is identical with the exception of the packing lantern ring being omitted and replaced with a fifth packing ring. The flushing tube is also eliminated.

1510 S Stuffing Box (With Special Single Mechanical Seal)

To replace the single mechanical seal remove pump assembly from the volute by following instructions as outlined for model 1510-PF. After the pump has been removed the next step is to remove the impeller. Removing the seal cap bolts and capscrews from the volute coverplate allows the coverplate to be removed exposing the seal.

Important: Note position of seal assembly on pump shaft. When installing replacement seal it must locate at positioning undercut in the shaft sleeve. To assemble, place seal carbon in seal cap and carefully put in position over pump shaft. Lubricate the "O" ring of the rotating seal member and install on shaft. Place volute coverplate in position and bolt to pump bracket. Carefully place seal cap with carbon insert in position against rotating seal member and bolt in place. Complete re-assembly by reversing removal instructions.

1510-D Stuffing Box (With Special Double Mechanical Seal)

To replace double mechanical seal remove pump assembly from volute by following instructions as outlined for model 1510 PF. After the pump has been removed the next step is to remove the impeller. Remove capscrews from the volute coverplate and pull entire assembly from the pump shaft. The seal cap and seal can now be removed from the stuffing box.

To assemble, place the seal cap and one seal carbon with the "O" ring toward the cap in position on the pump shaft. Lubricate the "O" rings of the rotating seal member and position on the shaft against the carbon. Install the second seal carbon in the bottom of the stuffing box with the "O" ring down and carefully position and bolt to the pump bracket. Move the first seal carbon in position against the rotating seal member and bolt the seal cap in place. Complete re-assembly by reversing removal instructions.

1510 (With Standard Mechanical Seal)

To replace the standard mechanical seal remove pump assembly from the volute by following instructions as outlined for model 1510-PF. After the pump has been removed the next step is to remove the impeller exposing the seal assembly. To remove the rotating portion of the seal use a screwdriver to break loose the rubber ring from the shaft and pull it forward. The seal insert and insert gasket can then be removed from its position in the volute coverplate. To assemble pump, reverse the above procedure. Care should be taken to avoid getting grease or oil on the seal faces.

If trouble occurs that cannot be rectified, contact your local B&G representative. We will need the following information in order to give you our best help:

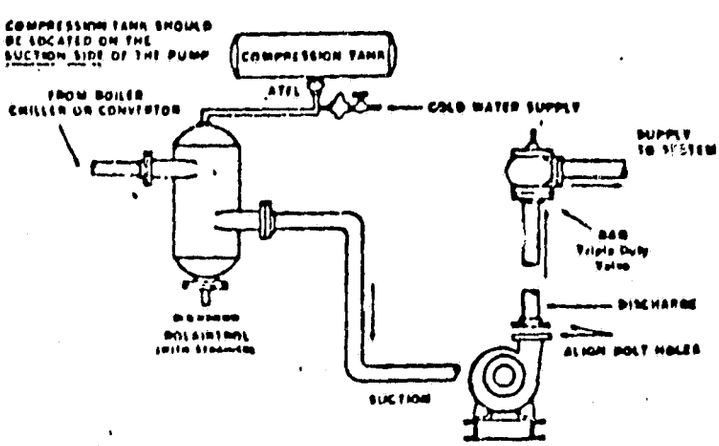
1. Complete nameplate data of pump and motor.
2. Suction and discharge gauge readings.
3. Ampere draw of the motor.
4. A sketch of the pump hook-up and piping.

GENERAL INSTRUCTIONS

1. Keep this pump and motor properly lubricated.
2. Protect the motor against overload and low-voltage. Use a motor-starter with proper size heater elements.
3. When there is danger of freezing, remove the plugs at the top and bottom of the volute shell.

WARNING

DO NOT RUN THIS PUMP DRY. CHECK ALIGNMENT BEFORE STARTING. LUBRICATE CORRECTLY. USE RECOMMENDED MOTOR-OVERLOAD PROTECTION.



REPLACEMENT PARTS FOR SERIES 1510 TYPE B CENTRIFUGAL PUMPS

PUMP SIZE	CONST	BALL BRG. ASSEMBLY	SLEEVE BRG. ASSEMBLY	IMPELLER	VOLUTE	COUPLER	SEAL ASSEMBLY	VOLUTE COVERPLATE	VOLUTE GASKET
"A" AND "AB" SIZES WITH 1" SHAFT DIAMETER AT COUPLER	BF	185011	186660	SEE CHART	SEE CHART	SEE CHART	186862	186482	P57700
	BFS	185013	P14790				186862	186482	P57700
	AB	185013	P14790				186862	P56780	P57700
	AI	185012					186860	186483	P57700
"B" AND "BB" SIZES WITH 1" SHAFT DIAMETER AT COUPLER	BF	185011	186660	SEE CHART	SEE CHART	SEE CHART	186862	186495	P48690
	BFS	185013	P14790				186862	186495	P48690
	AB	185013	P14790				186862	P56800	P48690
	AI	185012					186860	P61460	P48690
"A" AND "AB" SIZES WITH 1-1/4" SHAFT DIAMETER AT COUPLER	BF	185014		SEE CHART	SEE CHART	SEE CHART	186543	P49940	P57700
	BFS	185016					186543	P49940	P57700
	AB	185016					186543	P49960	P57700
	AI	185015					186544	P49940	P57700
"B" AND "BB" SIZES WITH 1-1/4" SHAFT DIAMETER AT COUPLER	BF	185014		SEE CHART	SEE CHART	SEE CHART	186543	P51540	P48690
	BFS	185016					186543	P51540	P48690
	AB	185016					186543	P51560	P48690
	AI	185015					186544	P51540	P48690
ALL "C" SIZES	BF	185014		SEE CHART	SEE CHART	SEE CHART	186543	P51523	P57770
	BFS	185016					186543	P51523	P57770
	AI	185015					186544	P51523	P57770

COUPLER SELECTION TABLE

PUMP SIZE	FRAME SIZE	SHAFT SPACE	H.P.	MOTOR SHAFT SIZE	COUPLER	COUPLER SLEEVE
FOR PUMPS WITH 1" SHAFT DIAMETER	56	1-1/4"	1/2 – 3/4	5/8"	P63230	P78804
	143T – 145T	1-3/4"	1 – 1-1/2 – 2 – 3	7/8"	P63231	P78804
	182T – 184T	1-3/4"	2 – 3 – 5 – 7-1/2	1-1/8"	P63233	P78729
	213T	2-1/2"	5 – 7-1/2 – 10	1-3/8"	P63235	P78791
	215T	2-1/2"	7-1/2 – 10 – 15	1-3/8"	P63235	P78791
	254T	2-1/2"	15 – 20	1-5/8"	P63238	P78792
	256T	2-1/2"	20 – 25	1-5/8"	P63240	P78794
FOR PUMPS WITH 1-1/4" SHAFT DIAMETER	213T	3-3/4"	7-1/2	1-3/8"	P63236	P78791
	215T	3-3/4"	10	1-3/8"	P63236	P78791
	254T	3-3/4"	15	1-5/8"	P63239	P78792
	256T	3-3/4"	20	1-5/8"	P63241	P78794
	284T	3-3/4"	25	1-7/8"	P63242	P78794
	284T	4" *	25	1-7/8"	P63243	P78794
	286T	3-3/4"	30	1-7/8"	P63244	P78796
	286T	4" *	30	1-7/8"	P63244	P78796
	284TS	3-3/4"	30	1-5/8"	P63239	P78792
	286TS	3-3/4"	40	1-5/8"	P63241	P78794
	324T	4" *	40	2-1/8"	P63245	P78796
	326T	4" *	50	2-1/8"	P63247	P78798
	324TS	3-3/4"	50	1-7/8"	P63242	P78794
	326TS	3-3/4"	60	1-7/8"	P63242	P78794
	364T	4" *	60	2-3/8"	P63248	P78798
	365T	4" *	75	2-3/8"	P63250	P78802

* 6C AND 8C

BEARING ASSEMBLIES

BALL BEARING

BEARING ASSEMBLY	SHAFT	IMPELLER SCREW	IMPELLER WASHER	IMPELLER LOCK WASHER	IMPELLER KEY
185011	P78927	P52320	P46380	P04650	H32400
185012	P78927	P52320	P46380	P04650	H32400
185013	P79018	552350	P46390	P04660	H32500
185014	P79008	K04500	P51230	P11200	H32600
185015	P79008	K04500	P51230	P11200	H32600
185016	P79066	P13800	P51250	P13160	H32700

BALL BEARING

BEARING ASSEMBLY	BEARING CAP	SHAFT SLEEVE	WATER SLINGER	BALL BEARING (PUMP END)	BALL BEARING (COUPLER END)
185011	P75606	185140	P53550	J92415	J92410
185012	P75606	185141	P53550	J92415	J92410
185013	P75606		P53550	J92415	J92410
185014	P75608	185142	P53720	J92412	J92416
185015	P75608	185143	P53720	J92412	J92416
185016	P75608		P53720	J92412	J92416

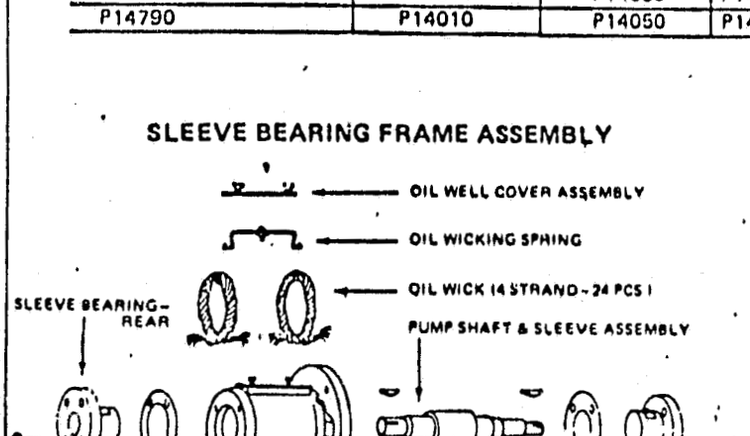
SLEEVE BEARING

BEARING ASSEMBLY	SHAFT AND SLEEVE	OIL WICK	IMPELLER CAP SCREW	IMPELLER WASHER	IMPELLER LOCK WASHER	IMPELLER KEY
186660	186628	118624	P52320	P46380	P04650	H32400
P14790	P14100	P52470	P52320	P46380	P04650	H32400

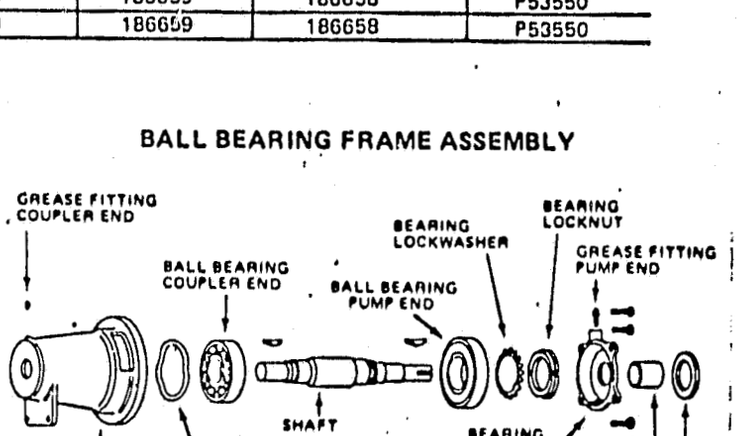
SLEEVE BEARING

BEARING ASSEMBLY	OILER	OIL WELL COVER		SLEEVE BEARING (FRONT)	SLEEVE BEARING (REAR)	WATER SLINGER
		BEFORE JUNE 1965 (FE)	AFTER MAY 1965 (EE)			
186660	P14010	P14050	P14051	186659	186658	P53550
P14790	P14010	P14050	P14051	186659	186658	P53550

SLEEVE BEARING FRAME ASSEMBLY



BALL BEARING FRAME ASSEMBLY



IMPELLER AND VOLUTE SELECTION CHART

PUMP SIZE	IMPELLERS					VOLUTES	
	IMP. DIA.	STANDARD BORE (7/8"ID)		LARGE BORE (1-1/4"ID)			
		BRONZE	CAST IRON	BRONZE	CAST IRON	BRONZE	CAST IRON
1-1/4" A	7"	186174	186171			P41260	186079
	6 5/8"	P46632					
	6-1/4"	P46650					
	6"	P46634					
	5-3/8"	P46670					
	5-1/8"	P46636					
	4-11/16"	P46680					
1-1/2" A AND 2" AB	7"	186203	186198	P48070	P48050	P41710	186088
	6-7/8"	P47952					
	6-1/2"	P47970					
	6-3/8"	P47958					
	6-1/4"	P47956					
	5-3/4"	P47990					
	5-1/2"	P48010				P42090	186099
	5-1/4"	P48030					
	5-1/8"	P47954					
2-1/2" A	7"	186225	P48770	P49040	P48980	P42380	186105
	6-3/4"	P49020					
	6-1/2"	P11640					
	6"	P11660					
	5-1/4"	P11670					
3" A*	7"	P49500	P49480	P49540	P49520	N/A	N/A
3" AB	7"	P78280	P78310	P77590	P77620	P42990	186118
	6-7/8"	P77560					
	6"	P78282					
	5-5/8"	P78284					
4" AB	7"	P56140	P50270	P50310	P50290	P55280	186128
	6-1/2"	P13930					
1-1/4" BB AND 1-1/2" BB	9-1/2"	P78523	P78253	P78251	P78522	P41430	186083
	9-1/8"	P78527					
	8-1/2"	P78528					
	8-1/8"	P78529					
	7-3/4"	P78531				186092	186091
2" B AND 2½" B	9-1/2"	186825	P78486	P78255	P78257	P42160	186101
	9"	P77457					
	8-1/2"	P77448					
	8-1/4"	P77455					
	8"	P77453				P55190	186109
	7-1/4"	P77451					
3" BB	9-1/2"	186241	P49600	P49640	P49660	P42770	P42740
4" BB	9-1/2"	186259	P50390	P50570	P50330	P55320	186130
	9-1/8"	P50552					
	8-3/4"	P12080					
	8-3/8"	P50554					
	7-1/2"	P50556					
5" BB	9-1/2"	P50930	P50910	P50970	P50950	P55360	186139
	8-1/2"	P13940					
	7-3/4"	P13970					
	7-1/4"	P13950					
6" BB	9-1/2"	P51330		P51290	P51270	P43750	186140
	9"			P12310			
2" C	12-1/2"			P77497	P77499		P42865
2" CB	12-1/2"			P77497	P77499		P43892
3" C	12-1/2"			P49700	P49680		P42880
3" CB	12-1/2"			P77501			P43902
4" C	12-1/2"			P50450	P50430		P43380
4" CB	12-1/2"			P77505			P43912
5" CB	12-1/2"			P77509			P43922
6" C	12-1/2"			P51370	P51350		P43810
6" CB	12-1/2"			P77513			P43932
8" C	12-1/2"			P51900	P51880		P44350

* IF NEW IMPELLER REQUIRED 3A PUMPS MUST BE CONVERTED TO 3AB BY ALSO CHANGING VOLUTE.

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BELL & GOSSETT
8200 N. AUSTIN AVE. • MORTON GROVE, IL 60053

Revised 3/15/79

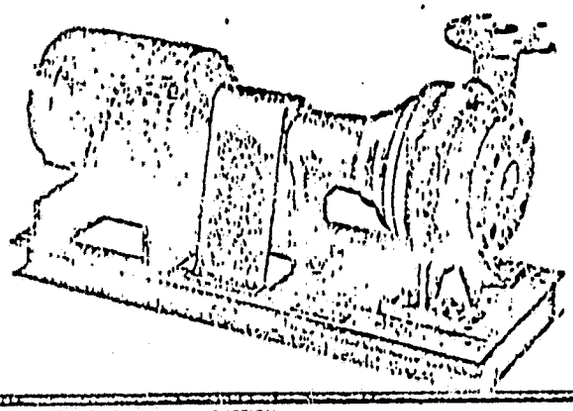
BELL & GOSSETT PRODUCTS

CENTRIFUGAL PUMPS SUBMITTAL **B-224.8** REVISION 4

2BB

Centrifugal Pumps—Base Mounted

SERIES 1510 TYPE B



JOB Lutz-Sotire Building
Stamford, Conn.

UNIT TAG NO. _____

ENGINEER Sanford Hess

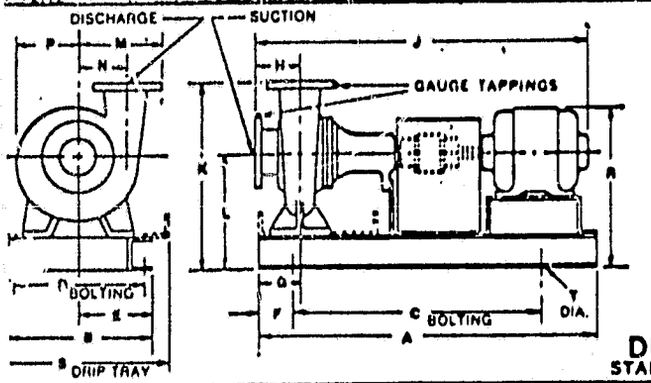
CONTRACTOR _____

B & G REPRESENTATIVE The Bernard M. Packtor Co.

ORDER NO. _____ DATE _____

SUBMITTED BY _____ DATE _____

APPROVED BY _____ DATE _____



SPECIFICATIONS

130 GPM 70 FT.

MATERIALS OF CONSTRUCTION:

☒ BRONZE FITTED ☐ ALL IRON ☐ ALL BRONZE

ELECTRICAL DATA: 5 HP

208 VOLTS 60 CY. 3 PH.

MOTOR ENCL. _____

SPEC. CONSTR. _____

APPROXIMATE WEIGHT _____ LBS.

☒ 1510 (Standard Seal)

☐ 1510-PF (Packing—Flushed)

☐ 1510-S (Single Seal)

☐ 1510-D (Double Seal)

FLANGES ARE 125# A.S.A.
MAXIMUM WORKING PRESSURE 175 PSI

DIMENSIONS
STANDARD SEAL 1510

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2BB	2½"	143T 145T 182T 184T	31	14⅛	25	12⅞	7¼	3	4¼	3¼	28¼ 29¼ 30⅛ 31⅛	17¼	10¼	8⅞	5⅛	6½	14⅛ 15⅛	13¾	¾
		213T 215T	34⅛		28⅛						33¼ 34¼						16¼		
		"L" FRAME																	
		215T 254T	39⅛	14⅛	33⅛	12⅞	7⅛	3	4¼	3¼	39⅛ 42¼	17¼ 19	10¼ 12	8⅞	5⅛	6½	16⅛ 18¼	13¾	¾
		256T 284TS 286TS 324TS 326TS	46½	16	36½	14	8	5	5⅛	3¼	44¼ 43½ 45¼ 46¼ 47¾	20 19	13 12				20		⅞

STUFFING BOX 1510-P, 1510-PF, 1510-S, 1510-D

PUMP SIZE	SUCTION SIZE	MOTOR FRAME	PUMP DIMENSIONS (INCHES) A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
		"S" FRAME																	
2BB	2½"	143T 145T 182T 184T	34⅛	14⅛	28⅛	12⅞	7¼	3	4¼	3¼	31⅞ 32¾ 33¼ 34¼	17¼	10¼	8⅞	5⅛	6½	14⅛ 15⅛	13¾	¾
		213T 215T	39⅛		33⅛						36⅞ 38⅛						16¼		
		"L" FRAME																	
		215T 254T	46½		36½						41¾ 44¼	19	12				17¾ 18¼		
		256T 284TS 286TS 324TS 326TS	51¾	16	41¾	14	8	5	5⅛	3¼	46¾ 45⅞ 47⅞ 48⅝ 50⅛	20 19	13 12	8⅞	5⅛	6½	20	13¾	⅞

ORIGINAL PAGE IS OF POOR QUALITY

1510 PERFORMANCE CURVES

PERFORMANCE CHARACTERISTIC CURVE

FOR 2"BB CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 1750 R.P.M.

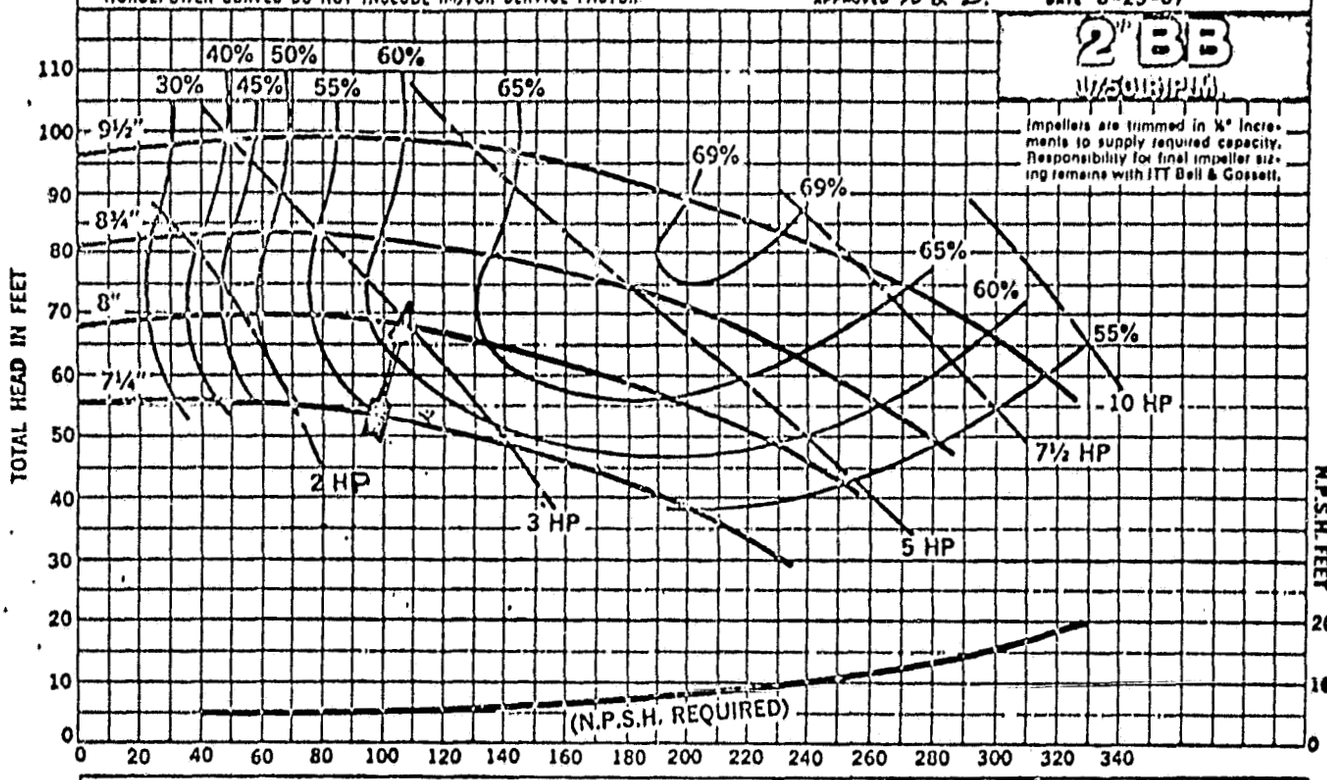
CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

110 GPM @ 70' Head

APPROVED G.L.D. DATE 8-25-67

2" BB 1750 R.P.M.

Impellers are trimmed in ¼" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



PERFORMANCE CHARACTERISTIC CURVE

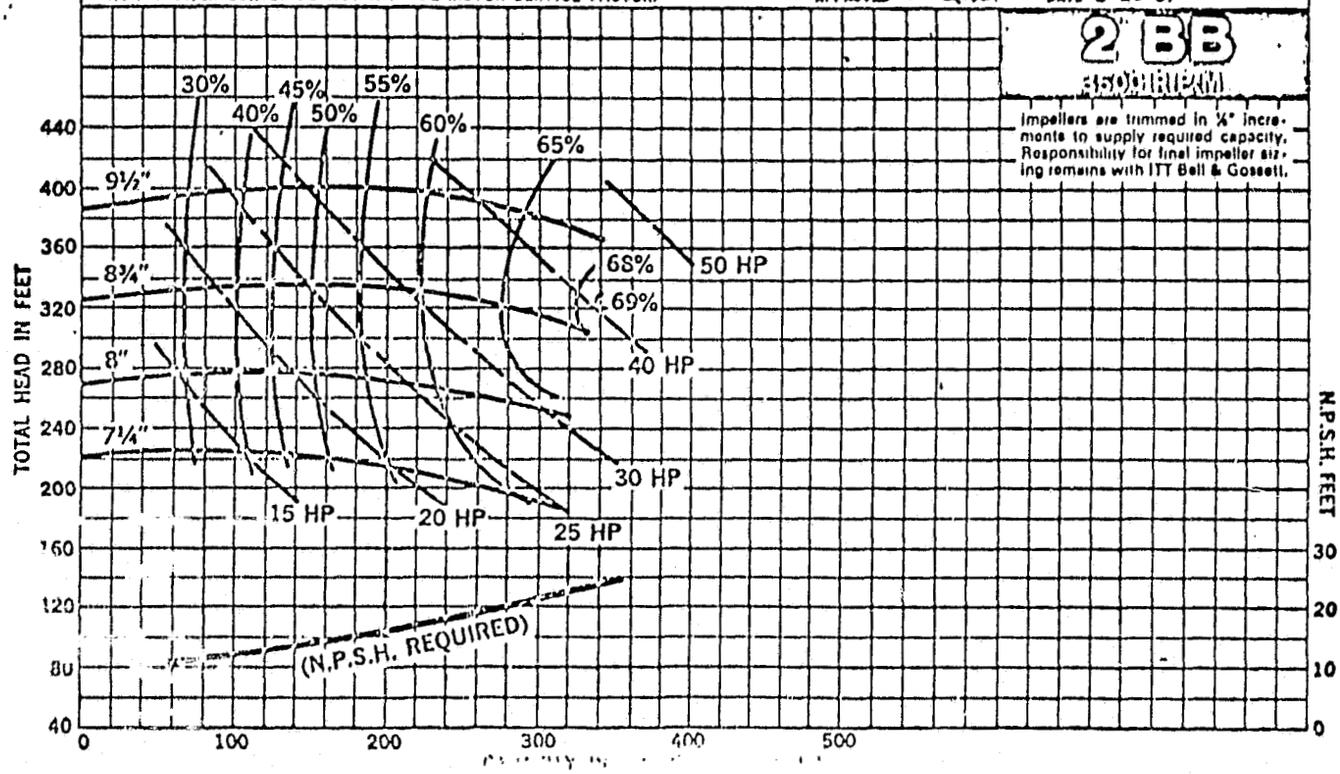
FOR 2"BB. CENTRIFUGAL PUMP FIG. NO. 1510 SPEED 3500 R.P.M.

CURVES BASED ON SHOP TEST USING CLEAR COLD WATER AT A TEMPERATURE OF NOT OVER 85°F. PERFORMANCE IS GUARANTEED AT INDICATED OPERATING POINT ONLY. HORSEPOWER CURVES DO NOT INCLUDE MOTOR SERVICE FACTOR.

APPROVED G.L.D. DATE 8-29-67

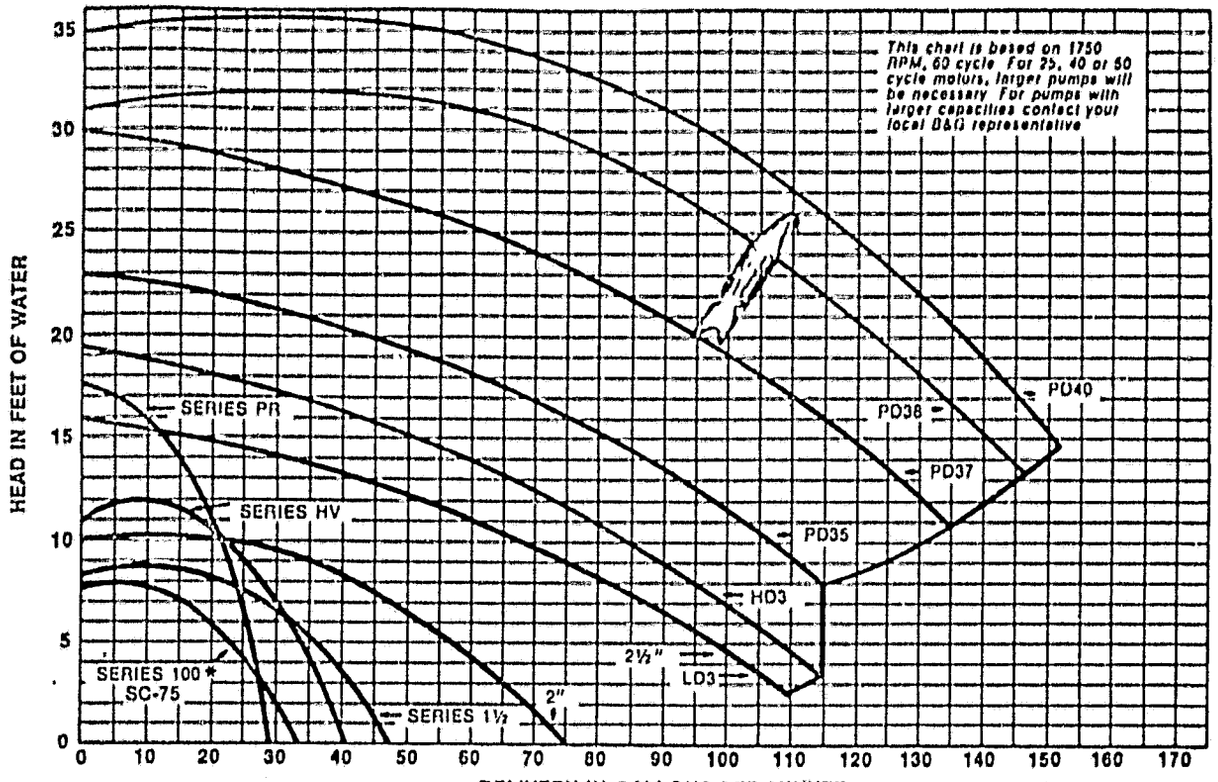
2" BB 3500 R.P.M.

Impellers are trimmed in ¼" increments to supply required capacity. Responsibility for final impeller sizing remains with ITT Bell & Gossett.



IRON AND BRONZE BOOSTER PUMP

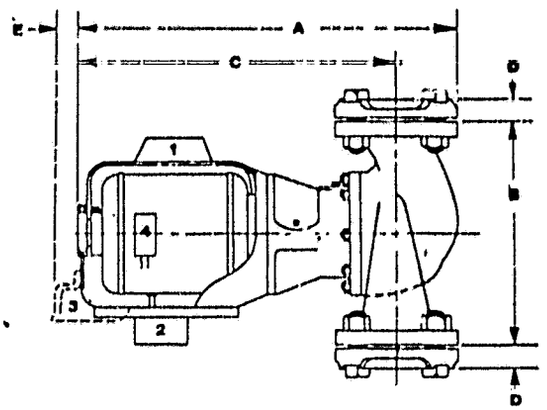
*Performance characteristics are based on using 1¼" or 1½" flanges. When using ¾" or 1" flanges performance will be slightly reduced.



110 GPM @ 26' Hd.

DIMENSIONS & WEIGHTS

MODEL NO.	FLANGE SIZE NPT INCHES (specify size)	DIMENSIONS IN INCHES (open drip-proof) A	B	C	D	E	APPROX. SHPG. WT. LBS. IRON BODY	BRONZE
SERIES 100	¾	15	6⅛	12⅛	9/16	—	21	21
	1 & 1¼				¾	—		
	1½				15/16	—		
SC-75	SWEAT		7⅛		—	—	—	20
SERIES PR	¾	16¼	8½	13⅛	9/16	—	38	39
	1 & 1¼				¾	—		
	1½				15/16	—		
SERIES HV	1	16⅛		13¾	⅝	—	28	28
	1¼ & 1½				¾	—		
SERIES 1½	1				⅝	—	30	
	1¼ & 1½				¾	—		
2	2	17⅛		14¼	15/16	—	40	40
2½	2½		10	14⅛	1⅛	—	59	62
LD3	3					—	58	63
HD3		18⅛		15⅛		—	62	68
PD35-S		20¼	12	17⅛		1⅛	78	84
PD35-T		20¼		16⅛			75	80
PD37-S		21¼		17⅛			85	84
PD37-T		20¼		17⅛			80	82
PD38-S		24	14½	19⅛	1¼	—	128	140
PD38-T		24¼		19¼		—	125	138
PD40-S		24⅝		20⅛		—	132	140
PD40-T		25⅛		20⅝		—	135	142



ELECTRICAL BOX ARRANGEMENT FOR BOOSTER PUMPS WITH BELL & GOSSETT MANUFACTURED MOTORS

Model Number	#1	#2	#3	#4
Series 100 and SC-75	All Standard			
Series PR, HV, 1½ and 2"	115 Volt	Other 1Ø	3Ø	
2½", LD3 and HD3		1Ø	3Ø	
PD35 and PD37			All	
PD38 and PD40				All

TYPICAL SPECIFICATION

The Contractor shall furnish and install In-The-Line Pumps as illustrated on the plans and in accordance with the following specifications:

1. The pumps shall be of the horizontal, oil-lubricated type, specifically designed and guaranteed for quiet operation. Suitable for 125# working pressure.

2. The pumps shall have a ground and polished steel shaft with integral thrust collar. The shaft shall be supported by two horizontal sleeve bearings designed to circulate oil. The pumps are to be equipped with water-tight seal to prevent leakage. Mechanical seal faces to be carbon on cast iron or ceramic. The motor shall be non-overloading at any point on pump curve.

3. The motor shall be of the open, drip-proof, sleeve-bearing, quiet-operating, rubber-mounted construction. Motors shall have built-in thermal overload protectors. (Exception—PD models with 3-phase motors, see paragraph 4 below.)

4. For PD models with 3-phase motors, add the following:
The Contractor shall furnish and install a magnetic starter for each booster pump, with at least two thermal overload protectors. The starter shall be equipped with manual reset buttons.

The pump shall be Bell & Gossett Model No. _____, or approved equal with a capacity of _____ GPM at _____ Ft. head when directly driven through a self-aligning flexible coupling by an oil-lubricated motor, _____ volts _____ cycle _____ phase(Ø).

BELL & GOSSETT

Heat Exchangers:

Heat exchangers are Bell and Gossett No. QWU-167-45, counterflow design, arranged in a series piping system. Heat transfer - 800,000 BTUH.

Shell Side

110 GPM, 50% glycol entering 100° to 93.7° leaving, pressure drop 13.5 ft.

Tube Side:

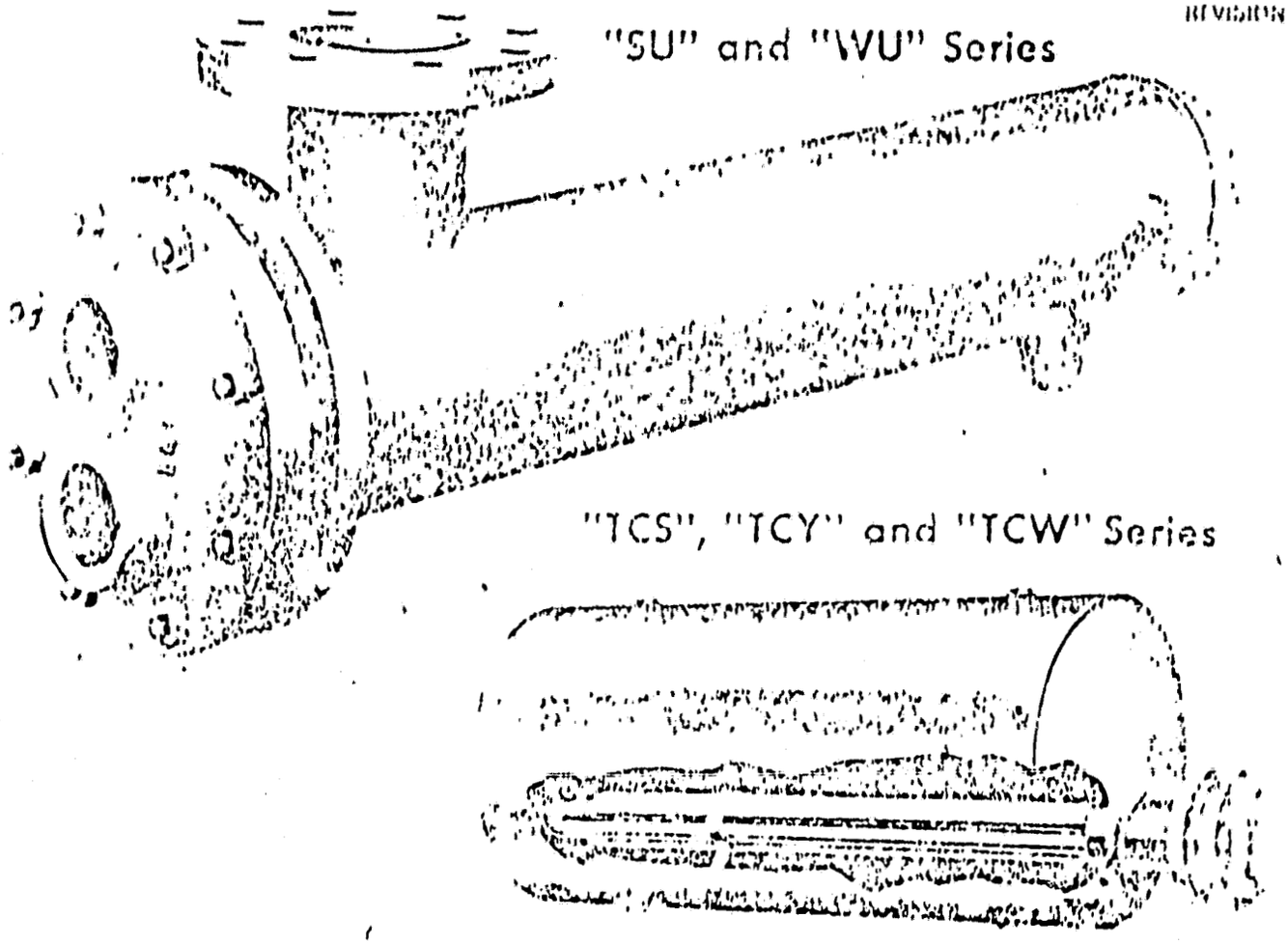
110 GPM, water entering 86.5°F leaving 101°F, pressure drop 3 ft.

The overall "U" factor is 229, and the total surface area is 508 sq.ft.

INSTRUCTION MANUAL

HT-60-IOM

REVISION 1



Installation, Operation and Maintenance Manual

for B & G "U" Series Heat Exchangers

BELL & GOSSETT ITT

FLUID HANDLING DIVISION

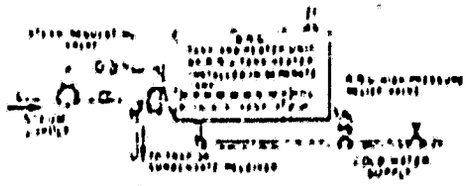


Figure 6—Typical Installation of "TCS" or "TCY" Tank Heater.

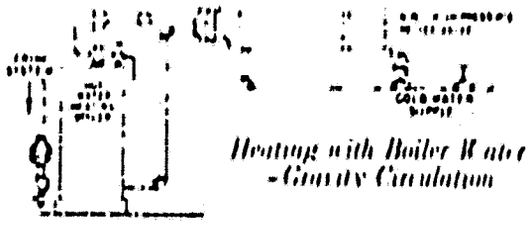


Figure 7--Typical Installation of "TCW" Tank Heater.

REPLACEMENT PARTS

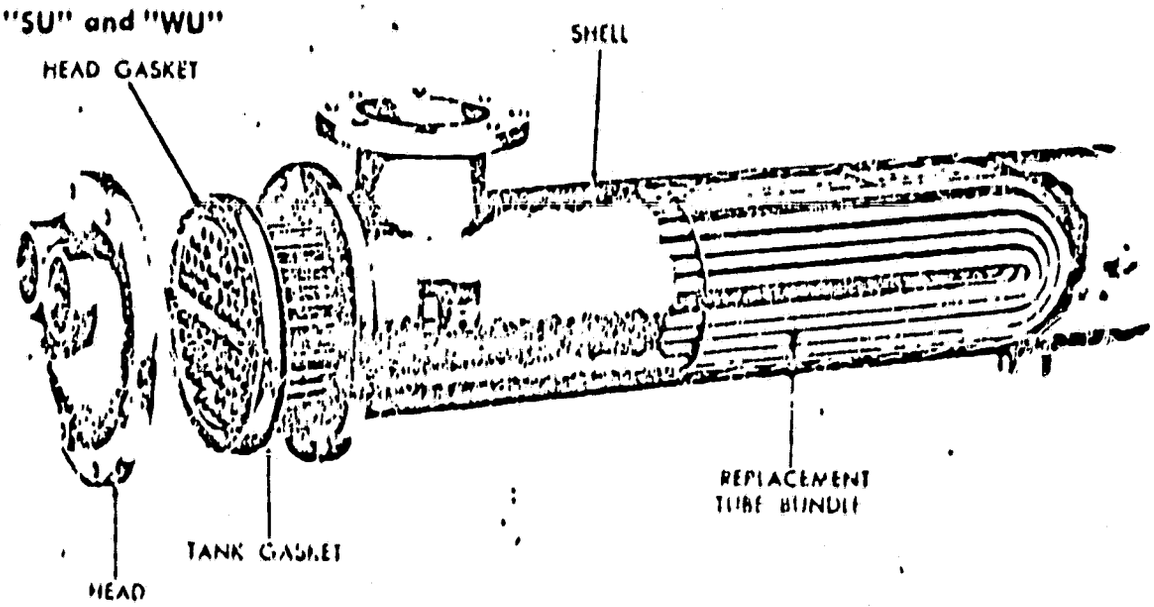
When replacement parts are required, refer to part number listed in the drawing of the proper unit. When ordering be sure full nameplate information on is given including Nat'l. Bd. No., Catalog, and Factory Number.

EXAMPLE:

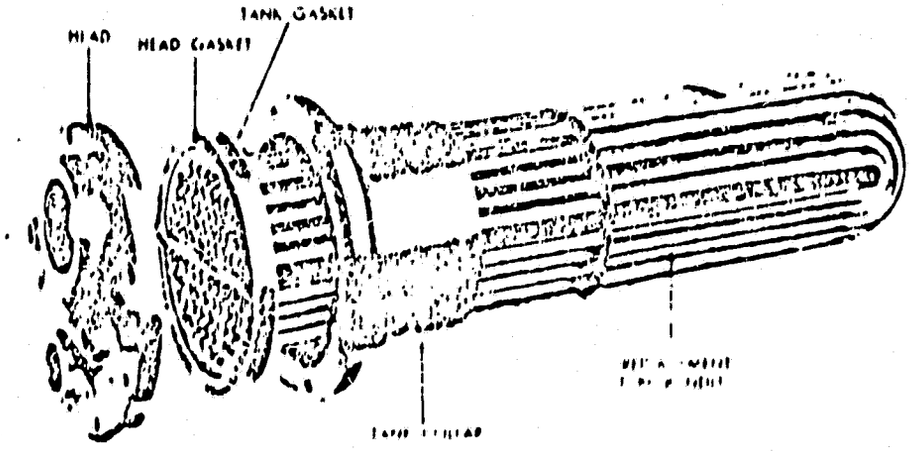
One replacement tube bundle for Nat'l. Bd. No. 349622
Catalog No. SU-46-2
Factory No. 125022

Note: Gaskets are always furnished with replacement tube bundles and need not be ordered separately.

"SU" and "WU"



"TCS", "TCY" and "TCW"



BELL & GOSSETT ITT

INSTRUCTIONS FOR B&G "U" SERIES HEAT EXCHANGERS

INSTALLATION

1. Provide sufficient clearance at the head of unit to permit removal of tube bundle from shell.

2. Provide valves and by-passes in the piping system so that both the shells and tube bundles may be by-passed to permit cutting out the unit for inspection or repairs.

3. Provide thermometer wells and pressure gauge connection in all piping to and from the unit and located as near the unit as possible.

4. Provide air vent cocks for unit so it can be purged to prevent or relieve vapor binding of either the tube bundle or the shell.

5. Foundations must be adequate so that exchangers will not settle and cause piping strain.

6. Loosen foundation bolts at one end of unit to allow free expansion of shells. Oval holes in foundation brackets are provided for this purpose.

7. Set exchangers level and square so that pipe connections may be made without forcing.

8. Inspect all openings in exchanger for foreign material. Do not expose units to the elements with pads or other covers removed from nozzles since rain water may enter the unit and cause severe damage due to freezing.

9. Be sure entire system is clean before starting operation to prevent plugging of tubes with sand or refuse.

10. Steam hammer can cause serious damage to the tubes of any Heat Exchanger. A careful consideration of the following points before an installation is made can prevent costly repairs which may be caused by Steam hammer.

(a) A vacuum breaker and or vent, should be used in accordance with the type of steam system installed.

(b) The proper trap for the steam system installed should be used.

(c) The trap and the condensate return line to the trap should be properly sized for the total capacity of the convertor.

(d) The trap should be sized for the pressure at the trap, not the inlet pressure to the steam controller.

11. For further exemplification of the above installation instructions see typical installation examples on page 3.

OPERATION

1. When placing a unit in operation, open the vent connections and start to circulate the cold medium only. Be sure that the passages in the exchanger are filled with the cold fluid before closing the vents. The hot medium should then be introduced gradually until all passages are filled with liquid.

2. Start operation gradually. Do not admit hot fluid to the unit suddenly when empty or cold. Do not shock unit with cold fluid when unit is hot.

3. When shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium, the circulation of hot medium should also be stopped by by-passing or otherwise.

4. Do not operate equipment under conditions in excess of those specified on name plate.

5. Drain all fluids when shutting down to eliminate possibility of freezing and corrosion. To guard against water hammer condensate should be drained from steam heaters and supply apparatus both when starting up and when shutting down.

MAINTENANCE

1. Provide means for frequently cleaning heat exchangers as is suggested below.

(a) Some cleaning compounds on the market, such as Oakite may be used to advantage for removing sludge or coke, provided hot wash oil or water does not give satisfactory results.

(b) If the above described method is ineffective for the removal of hard scale, a mechanical means may be used.

2. At regular intervals observe interior and external condition of all tubes and keep them clean. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes, with consequent overheating of these tubes as compared to surrounding tubes, resulting in leaking tube joints.

3. Do not attempt to clean tubes by blowing steam through individual tubes.

4. Do not open heads until all pressure is off equipment and the unit drained.

5. Do not handle tube bundles with hooks or other tools which might damage tubes. Bundles should be moved about on cradles or skids.

6. Exchangers subject to fouling should be cleaned periodically. A marked increase in pressure drop and or reduction in performance usually indicates cleaning is necessary. Since the difficulty of cleaning increases rapidly as the scale thickens or deposit increases, the intervals between cleanings should not be too great.

7. When removing tube bundles from exchangers for inspection or cleaning care should be exercised that they are not damaged by improper handling. Tube bundles are often of great weight, yet the tubes are small and of relatively thin metal.

In cleaning a tube bundle, tubes should not be hammered on with any metallic tool and in case it is necessary to use scrapers, care should be exercised that the scraper is not sharp enough to cut the metal of the tubes.

TYPICAL INSTALLATIONS

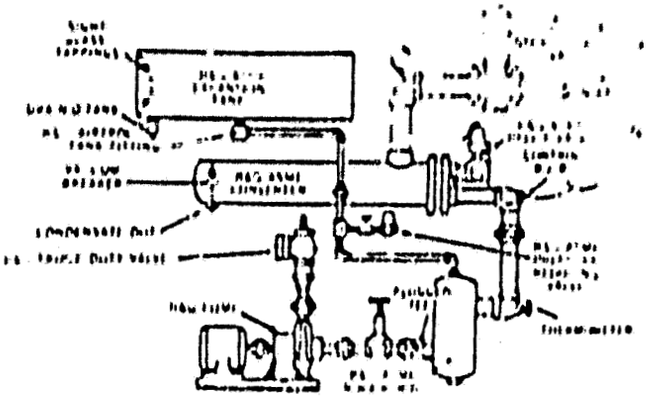


Figure 1—Typical installation of "SU" Heat Exchanger when used as a Converter.

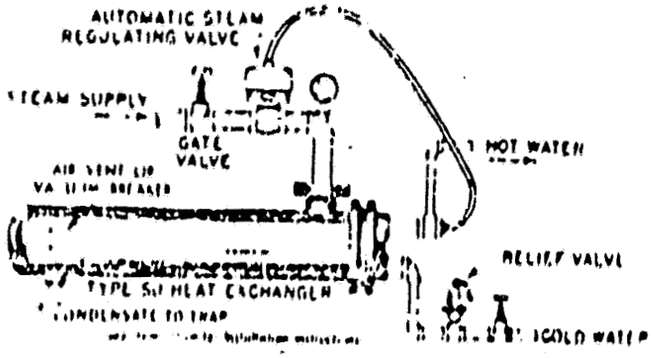


Figure 2—Typical installation of "SU" Heat Exchanger when used as an instantaneous Heater.

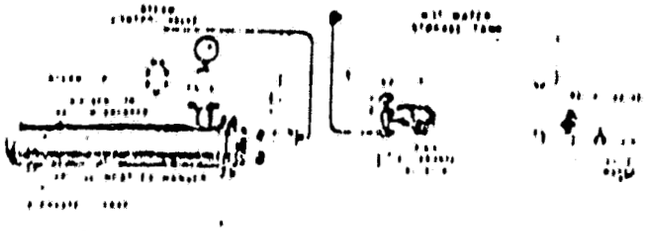
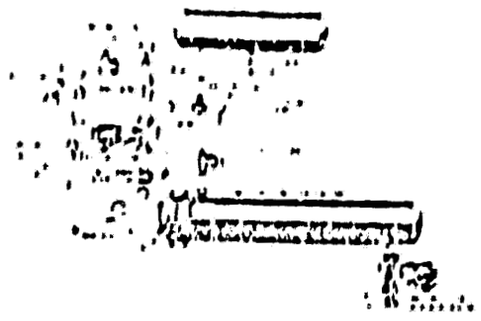


Figure 3—Typical installation of "SU" Heat Exchanger when used with storage tank.



For proper sizing of Aitrol System consult B&G Representative.

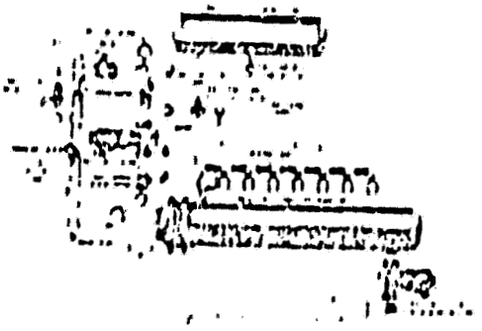
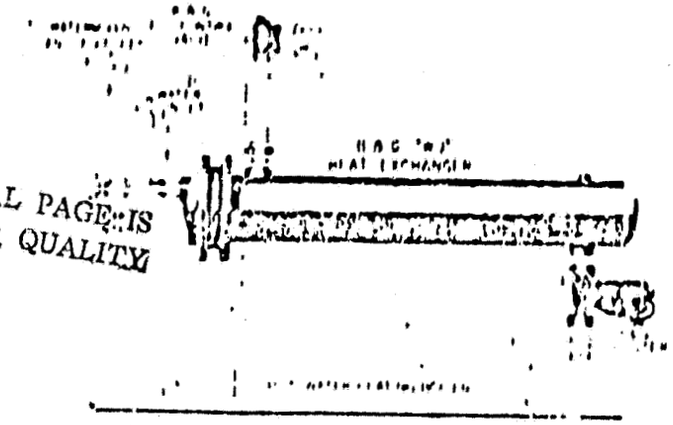
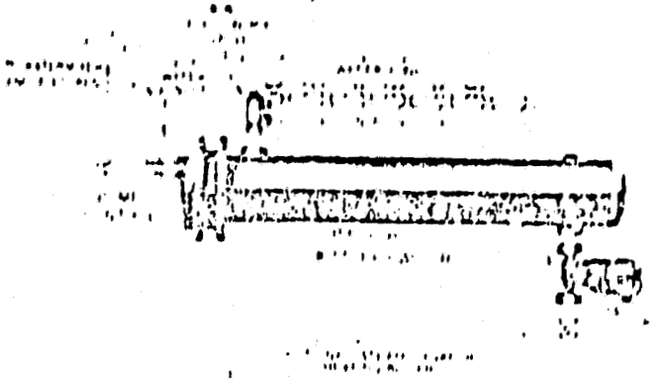


Figure 4—Typical installation of "WU" Heat Exchanger when used as a Converter.



Installation on hot water boiler

When the "WU" is to be fitted on a hot water boiler or source, a B&G Electrolier prevents electrolytic corrosion of boiler water when Heater is not in use.



Installation on steam boiler

When on a steam boiler note that boiler water is supplied to the "WU" Heater from the bottom of the boiler.

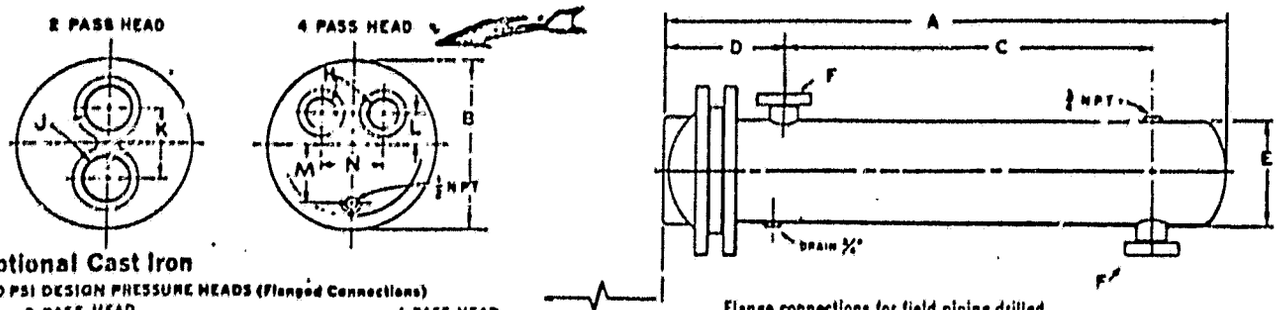
Figure 5—Typical installation of "WU" Heater.

*CAUTION:

Steam hammer can cause serious damage to the tubes of any Heat Exchanger. A careful consideration of the following points before an installation is made can prevent costly repairs which may be caused by steam hammer.

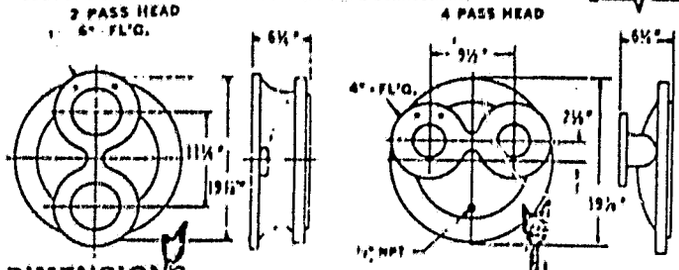
1. A vacuum breaker and or vent, should be used in accordance with the type of steam system installed.
2. The proper trap for the steam system installed should be used.
3. The trap and the condensate return line to the trap should be properly sized for the total capacity of the converter.
4. The trap should be sized for the differential pressure across the trap, not the inlet pressure to the steam control.

16" Series TYPE "WU" HEAT EXCHANGERS ("U" Tube Design)



Optional Cast Iron

150 PSI DESIGN PRESSURE HEADS (Flanged Connections)



Flange connections for field piping drilled and faced per 150# ANSI standards.

Room for removal of tube bundle, equal to or greater than "A", should be provided.

Cast iron or bolted steel legs can be supplied when specified.

DIMENSIONS

"WU" type "U" tube
Shell diameter in inches
Tube bundle length in feet
Number of tube passes
Baffle spacing in inches

Complete sales number consists of example: WU164-25

UNIT NUMBER		DIMENSIONS IN INCHES												HEATING SURFACE (SQ. FT.)		APPROX. SHIPPING (LBS.)
		2 PASS		4 PASS				2 AND 4 PASS								
2 Pass	4 Pass	J	K	H	L	M	N	A	B	C	D	E	F	2 Pass	4 Pass	(LBS.)
WU164-25	WU164-45	6 NPT	9⅛	4 NPT	4	7⅛	8	57¼	19⅛	34	14	16	6 FLG	150	143	787
WU165-25	WU165-45	6 NPT	9⅛	4 NPT	4	7⅛	8	69¼	19⅛	46	14	16	6 FLG	188	180	892
WU166-25	WU166-45	6 NPT	9⅛	4 NPT	4	7⅛	8	81¼	19⅛	58	14	16	6 FLG	227	217	997
WU167-25	WU167-45	6 NPT	9⅛	4 NPT	4	7⅛	8	93¼	19⅛	70	14	16	6 FLG	265	254	1102
WU168-25	WU168-45	6 NPT	9⅛	4 NPT	4	7⅛	8	105¼	19⅛	82	14	16	6 FLG	304	291	1207
WU169-25	WU169-45	6 NPT	9⅛	4 NPT	4	7⅛	8	117¼	19⅛	94	14	16	6 FLG	342	327	1312
WU164-210	WU164-410	6 NPT	9⅛	4 NPT	4	7⅛	8	57¼	19⅛	31¼	16	16	8 FLG	150	143	787
WU165-210	WU165-410	6 NPT	9⅛	4 NPT	4	7⅛	8	69¼	19⅛	43¼	16	16	8 FLG	188	180	892
WU166-210	WU166-410	6 NPT	9⅛	4 NPT	4	7⅛	8	81¼	19⅛	55¼	16	16	8 FLG	227	217	997
WU167-210	WU167-410	6 NPT	9⅛	4 NPT	4	7⅛	8	93¼	19⅛	67¼	16	16	8 FLG	265	254	1102
WU168-210	WU168-410	6 NPT	9⅛	4 NPT	4	7⅛	8	105¼	19⅛	79¼	16	16	8 FLG	[illegible]	291	1207
WU169-210	WU169-410	6 NPT	9⅛	4 NPT	4	7⅛	8	117¼	19⅛	91¼	16	16	8 FLG	342	327	1312

DESIGN PRESSURES—A.S.M.E. CONSTRUCTION CAST IRON & BRASS UNITS

DESIGN PRESSURES*				DESIGN TEMPERATURES* TUBE & SHELL SIDE	
TUBE SIDE		SHELL SIDE			
DESIGN	TEST	DESIGN	TEST	CAST IRON	BRASS
125 psi	250 psi	150 psi	300 psi	375 F	300 F
2 & 4 Pass Head (Flanged Connections) Cast Iron only					
150 psi	300 psi	150 psi	300 psi	375 F	—

*For design pressures and temperatures higher than shown, consult B & G Representative for specifications and dimensions.

Caution:
A properly sized relief valve must be installed on the heated water side to protect heat exchangers from possible damage due to volumetric expansion.

MATERIALS

PART	STANDARD CAST IRON UNIT	BRASS UNIT
	2 & 4	2 & 4 Pass
Shell	Steel	Steel
Head	Cast Iron	Cast Brass
Tubes ¾" O.D.	Copper	Copper
Tube Sheet	Steel	Rolled Naval Brass
Baffles	Steel	Steel
Nuts & Bolts	Steel	Steel

BELL & GOSSETT

PRINTED IN U.S.A. 8-76

Insulation:

On the solar collector piping and outdoor closed circuit cooler piping, urethane insulation was used. This was 1 1/2" thickness, ASJ jacket, applied in accordance with the manufacturer's recommendations. Butt ends, longitudinal seams, and ends were joined with joint adhesive (Benjamin Foster 81-33).

Underground piping was insulated by the application of Kippers #50 Bitumastic, embedding a 10 x 10 glass fabric into the coating. A second coat of Bitumastic and a second layer of glass fabric were applied, over which a final coat of Bitumastic was applied.

Outdoor piping was covered with vinyl jacketing (Zeston).

Plumbing connecting the heat exchanger to the thermal storage was insulated with a 1 1/2" thickness of urethane, applied and finished in a manner identical with Solar Collector Piping.

A new canvas jacket was applied to all roof piping at the time of the solar installation. Heat exchangers were insulated with a two piece sectional fiberglass pipe covering. this was four (4) PCF density, 1 1/2" thickness with type ASJ-SSL fire retardent jacket. Laps, butt joints, and strips were self-sealing.

All exterior surfaces of the closed circuit cooler and damper hood assembly were insulated with a 1" thickness of Armaflex sheet insulation. The storage tank was insulated by a 4" thickness of sprayed urethane and weather-proofing using Dow Corning 3-5000 silicone urethane foam covering.

Roofing:

5/8" gypsum board was applied over the steel deck using mechanical fastening. Eight insulfast special overdrive nails per 4'x8' board were used. (4 nails per 2'x8' board). The nails were driven through 2 1/8" diameter, pre-punched steel discs, using the pneumatically powered gun specially designed for driving insulfast nails. The boards were butted tightly and the joints staggered. Starting at the low point of the roof, the deck was mopped with Dead Level Asphalt at the rate of approximately 23 pounds per 100 sq.ft. Gypsum overlayment was solid mopped. Into the mopping, while hot, was embedded three plies of Vented Coating Roofing Felt. Starting strips 12" and 24" wide were followed by full width sheets. Each sheet 24-2/3" was lapped over the preceding sheet. The full width of the sheet was mopped with a continuous coating of Dead Level Asphalt (approximately 23 lbs. per 100 sq.ft) so that the felt did not touch felt. All plies were extended up face of cant and cut off evenly at the wall line. Over the entire surface was poured a uniform application of 45 lbs. per 100 sq.ft. of Dead Level Asphalt into which, while hot, was embedded a 2" thickness of Celotex Temp-Check insulation (Celotex IRA-250-C). Boards were walked in to obtain complete bonding. Approximately 15 lbs. per 100 sq.ft. Dead Level Asphalt was poured into all insulation joints. Over the entire surface of the installation was poured a uniform top coating of Dead Level Asphalt (approx. 60 lbs. per 100 sq.ft.) Into this hot asphalt was embedded one inch of roofing gravel. The gravel

surfacing was White Limestone Spar manufactured by Limestone Products Corporation of America , Newton, New Jersey.

Controls:

Heating and cooling of the building before the addition of the solar system was provided by water to air heat pumps (originally American Standard, now Singer), located at the perimeter of the building and supplemented by a roof top air conditioning and heating unit to provide heating and cooling, as well as fresh air to the core of the building.

The 80 heat pump units as well as the condensing unit for the roof top air conditioning unit have not been altered. They are tied into a single building water loop, as shown on the building flow schematic. Two circulators, HP pump PE1 and PE2, are provided, one in the standby condition to circulate water at a rate to 205 GPM through the 4" main circulating pipes. The 4" main supply loop divides into two 2" supply loops with gate valves, supplying the second and third floor, and a 3" supply loop for the roof top air conditioning condensing unit, which is bypassed when the unit is not operating.

Individual heat pumps may be either in the heating or cooling mode, depending on local conditions in individual offices throughout the building.

If the building is predominately in the heating mode, the ambient outside temperature is cold, most heat pumps are in the heating mode, and the building water loop is supplied at 80°F, and water is returned from the heat pumps at temperatures of approximately 77°F.

Before solar heating was installed, the returning water at 77°F was heated back up to 80°F by mixing water electrically heated to as high as 180°F, stored in the existing 2,800-gallon insulated, storage tank. The water was heated by circulating water using pump PE3 from the 2,800-gallon existing storage tank through the two 150 KVA boilers. Day/night cycle control specifications were provided to operate the boilers at off-peak hours. The day/night switchover was operated by a time clock. The boilers were energized through the internal operating aquastats of each boiler. On the day cycle, a time clock prevented the operation of the pump, subject to override by the H-O-A switch.

Incorporating solar heating required the addition of the 6,000-gallon tank and the array of collectors, but required little modification of the existing heating system. Solar heated water is used in preference to electrically heated water, but the distribution loop to the heat pumps remains unchanged. The temperature of the water supplied to the building loop is sensed by thermostats T-1 and T-2. T-2 is a previously existing control thermostat; T-1 is a new control thermostat. T-1 modulates a 3-way valve, as required to maintain its set point. The 3-way valve proportions the flow of hot water from the solar storage tank, a low limit theromstat (T-3) closes the valve to the tank and the previously existing controller (T-2) is in control. The system then operates on the electric boilers.

Thermostat T-2 controls the previously existing 3-way diverting valve V-2 in such a manner that sufficient hot water from the 2,800-gallon storage tank is mixed with the returning water to bring its temperature to 80°F.

A closed circuit evaporative cooler is in the building loop. If more than one-third of the heat pumps in the building operate in the cooling mode, the heat of rejection from the cooling units exceeds the heat load from the units operating in the heating mode, and the returning water is then warmer than 80°F. In this case, the closed circuit evaporative cooler is operated to cool the returning water to below 85°F.

Control of circulation through the collectors is governed by the operation of a Natural Power, Inc. differential controller. Sensor Ts is on one of the solar collectors and sensor Tt is in the storage tank. When Ts is 25°F hotter than Tt circulation begins, and when the differential drops to 120°F, the pumps shuts off.

The collector manufacturer, Sunworks, recommends a flow rate of 1 gpm per collector increased from 0.5 gpm to optimize heat transfer from the collectors and to minimize collector fin loss. The circulator pump used is a 125 gpm unit with a 5HP motor.

Electrical:

All conductors are copper and are U.L. rated for operation at 600VAC. The building feeders are Type THW and THWN, and all branch circuit power wiring is Type THW. Color identification is uniform and continuous throughout, according to this legend:

1. Neutral — White
2. Equipment ground wire — Green
3. Phase A — Black
4. Phase B — Red
5. Phase C — Blue

No wire smaller than #12 AWG was used for power wiring, and #14 was used for control wiring. Wire that is eight B&S gauge and larger is stranded, and smaller wire sizes are solid copper.

Wiring methods included the use of electric metallic tubing (EMT) and "Sealtight" conduit. The electric metallic tubing is a threadless thin wall conduit, used with compression fittings. These are U.L. labeled, ANSI C80.3, galvanized, and have a 3/4" minimum size. It was used for branch circuits in masonry partitions, furred ceilings, exposed dry locations, and in feeders that are above grade. The "Sealtight" conduit was used for the final connections to motors. In this application, the National Electric Code (NEC) limits the conduit to a length less than 18". Also, a separate ground conductor from panelboard was provided when using Sealtight conduit.

Both types of conduits are secured to boxes and cabinets with locknuts and bushings. Conduit is supported by hangers placed on not more than 5 foot centers. In addition, hangers, supports, or fastenings have been provided at each elbow and each end of straight runs that terminate in a box or cabinet.

Horizontal and vertical runs are supported with one hole malleable straps, clampbacks, inserts or other suitable devices. These include bolts, expansion shields, beam clamps, or special brackets as necessary for mounting to the building structure.

Solderless, pressure type connectors were used for all control wiring terminations. For power wiring terminations to fixture leads, circuit connections were made by solderless, screw type connectors. All other connections were made by solderless, bolted pressure type connectors, including wire sizes larger than #8.

Outlet boxes are of galvanized steel. They are firmly secured to walls, beams, studs, and in no case are dependent on the conduit for support. Junction or pull boxes were provided as required. (For instance, to facilitate cable pulling or splicing.) Boxes were sized as required by N.E.C. for the number of conduits and conductors entering or leaving.

After installation, all circuits were tested for short circuits, open circuits, and grounds.

- M A N U A L -

of

INSTALLATION, OPERATION & MAINTENANCE

- DIFFERENTIAL THERMOSTAT -
Series S25

Notice

Read carefully all sections of this Manual through "Operation" before installing and using this instrument to ensure satisfactory operation.

NATURAL POWER INC.
Francestown Turnpike
New Boston, NH 03070
(603) 487-5512
5513

- LIMITED WARRANTY -

Natural Power Inc. products are carefully designed to perform accurately and efficiently under the specified conditions. Natural Power Inc. warrants to the original purchaser that, should there be any defects in materials or workmanship during the first year after purchase, Natural Power will repair or replace, at its discretion, the defective component(s); provided that:

A) the product has not been subjected to abuse, neglect, accident, alteration, improper installation or servicing, or use in violation of instructions furnished by NPI;

B) the product has not been repaired or altered by anyone except NPI or its authorized service agencies;

C) the serial number has not been removed, defaced or otherwise changed; and

D) the damage has not been caused by acts of God including windstorm and hail.

This limited warranty of Natural Power Inc. does not apply to any component or machinery resold by Natural Power Inc. in its original condition as received from the manufacturer or distributor nor to damage caused by shipping.

This limited warranty is in lieu of all obligations or liabilities on the part of Natural Power Inc. for damages, including, but not limited to, consequential and incidental damages arising out of or in connection with the use of the product. No representative or person is authorized to give any other warranty or assume for NPI any other liability in connection with the sale of its products.

This limited warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

This warranty complies with the 1975 Federal Warranty Law and completely replaces any warranty printed on promotional material describing the products of Natural Power Inc.

INTRODUCTION

The NPI Series S25, Differential Thermostats are reliable and economical devices for controlling two-element active solar systems such as are used for heating domestic hot water or swimming pools. The Differential Thermostat senses the difference in temperature between two points in the system; generally the temperature difference between the collector and the water pre-heater pool, or storage and activates the system's pump valve blower, or damper when the temperature difference reaches a preset value. It then maintains operation until the temperature difference falls below an independently set lower value.

Every Series S25, Differential Thermostat is provided with the means to measure and adjust the "on" and "off" temperature differences, and to test the operation of the Differential Thermostat and system elements under simulated conditions. Each Series S25, Differential Thermostat is normally furnished with two Model S90-100, Air/Surface Temperature Sensors. On request, Model S91-100, Liquid Temperature Sensors can be substituted.

THEORY OF OPERATION

The Series S25, Differential Thermostats use two resistance temperature sensors to sense the temperature of the two components of the solar heating system to be controlled. These sensors form one leg in each of two bridge circuits within the Differential Thermostat. Each bridge circuit, therefore, produces a voltage proportional to the temperature it is sensing (e.g. 0-10 volts DC = 0-250$^{o}F_{x}$).

The two voltages from the bridge circuits are fed into a difference circuit the output of which is a voltage proportional to the differential temperature between the two system components in which the resistance thermometers are located (e.g. 0-10 volts DC = 0-25^{o}F).

This difference voltage is in turn fed to an adjustable Schimitt Trigger circuit. This circuit triggers "on" when the difference voltage (proportional to the differential temperature) increases to a preset value. The trigger circuit then remains latched "on" until the voltage decreases to a lower preset value at which point it switches "off". During the time the trigger circuit is on, it is producing a voltage which is amplified and used to activate a power relay. The relay is used to control the system actuator (pump, blower, valve, etc.).

Thus, it can be seen that the Series S25, Differential Thermostat will start the solar heat collection system operating whenever the temperature difference between the solar collector and the heat storage device is sufficient to provide efficient transfer of thermal energy. It will then maintain the system in operation until the temperature difference falls below a point where thermal energy can no longer be efficiently transferred.

Two potentiometers are included in the Differential Thermostat for setting the values of the temperature difference at which the control device will turn on and turn off. A third potentiometer is provided which varies a voltage which can be substituted for the output of the difference circuit by means of a switch, permitting the entire system to be "exercised".

INSTALLATION

Mount the Series S25, Differential Thermostat using appropriate fasteners through the four holes in the mounting flanges on the thermostat case at a convenient height above the floor in a sheltered area. The location chosen for the Thermostat should provide easy access, yet be away from normal traffic. It is often found best to locate the Differential Thermostat in the vicinity of the solar system's pump or blower.

INSTALLATION continued...

A grounded convenience outlet (or junction box) must be provided within 5 feet of the Thermostat into which the power cord is plugged. The motor of the pump or blower to be controlled is connected to the right-hand terminal strip using terminals marked "C" (common) and "NO" (normally open) as shown in the wiring diagram, Figure 1. Use insulated wire of sufficient gauge for this hook-up. If the current drawn by the device being controlled is likely to exceed 10 Amps. resistive, a follower relay or power contactor should be used (see Figure 1A). It is recommended that motors rated over 1/3 HP at 110VAC or 1/2 HP at 240VAC not be controlled directly by the Thermostat's relay. The "NC" (normally closed) contact is also available on the same terminal strip.

The proper placement and installation of the termperature sensors is essential to the efficient operation of the solar energy system. The particular design of the collector and the storage will affect the placement. In some systems, provision for the temperature sensors will have been included.

An excellent location for the sensor in the collector is on the absorber place within one foot of the outlet. Other satisfactory locations are on the inside or the outside surface close to the beginning of the outlet duct in air systems or on the surface of the outlet pipe in liquid systems. In all cases, the major consideration is to locate the sensor as close to the outlet of the collector as possible.

A dab of Heat Sink Compound, available from electronic supply houses applied between the sensor and the surface on which it is mounted, will increase contact and reduce thermal lag. The sensor can be fastened to the mounting surface with a fuse clip, hose clamp, adhesive such as General Electric's "Silastic or Dow, Corning's "RTV", or other suitable reliable means.

If a liquid sensor is to be used, it should be inserted in a tee installed in the piping system at the outlet of the

collector. All sensors mounted outside the system should be well covered with insulating material.

In all cases, mechanical strain relief for the temperature sensor leads should be provided.

In swimming pools, place the sensor at least one foot below the surface. It is more difficult to define the proper location of the temperature sensor in the storage tank or bin. It should be located as close as possible to that part of the storage which remains coldest.

In systems using liquid as the storage medium, install the temperature sensor close to the bottom of the tank. If a liquid sensor is used, it can be inserted through a threaded boss. Air type sensors can be inserted in a well if one is provided for the purpose, or attached to the outside of the tank using a mechanical clamp or strap, or with adhesive. Again, a dab of heat sink compound under the sensor is recommended, as well as a cover of insulation.

Rock storage bins as used in air systems should contain one or more probe tubes extending well into, or through the bin. Probe tubes may consist of 1/2" copper tubing, electrical conduit, or ordinary pipe. The interior end of the probe tubes must be capped or plugged to prevent the escape of warmed air or excessive convection. The temperature sensor is inserted in a probe tube well into the interior of the rock storage bin. The position of the sensor may have to be adjusted to ensure that the temperature of the coldest part of the bin is being detected. The sensor within the power tube will accurately measure the temperature of the surrounding medium since there is very little convection in a small diameter tube.

The temperature sensors are connected to the Differential Thermostat using two-conductor #18 AWG thermostat wire. Each sensor can be located as much as 1,000 feet from the thermostat without introducing appreciable error. Connection is made at the left-hand terminal block in the Differential Thermostat to the two terminals marked "Collector" and the two marked "Storage" Once this is done, the system is ready to operate.

OPERATION

Open the front of the S25, Differential Thermostat case and set the differential temperature at which you want the solar system to turn on and off by adjusting the two potentiometers located on the upper right section of the circuit board and marked "on" and "off". The settings should be those established by the system designer or installer. If none has been specified, try initial settings of 15° "on", and 5° "off". Keep in mind that air systems usually require a wide differential while liquid systems operate efficiently with a narrow differneital.

Put the power switch on the front of the Thermostat case in the "on" position. Move the slide switch in the center of the circuit board to the Test" position. Now, by rotating the test potentiometer located on the lower center of the circuit board just above the terminal blocks, the system can be cycled "on" and "off".

Note that the "System On" indicator located on the front cover of the Differential Thermostat lights up when the higher differential temperature is exceeded and goes out when the differential temperature drops below the lower "off" setting. At the same time, the power relay can be seen and heard to pull in and drip out.

After the "on" and "off" points are set, be sure to return the slide switch in the center of the terminal board to the "Qperate" position and close the front panel. Operation from this point on is automatic.

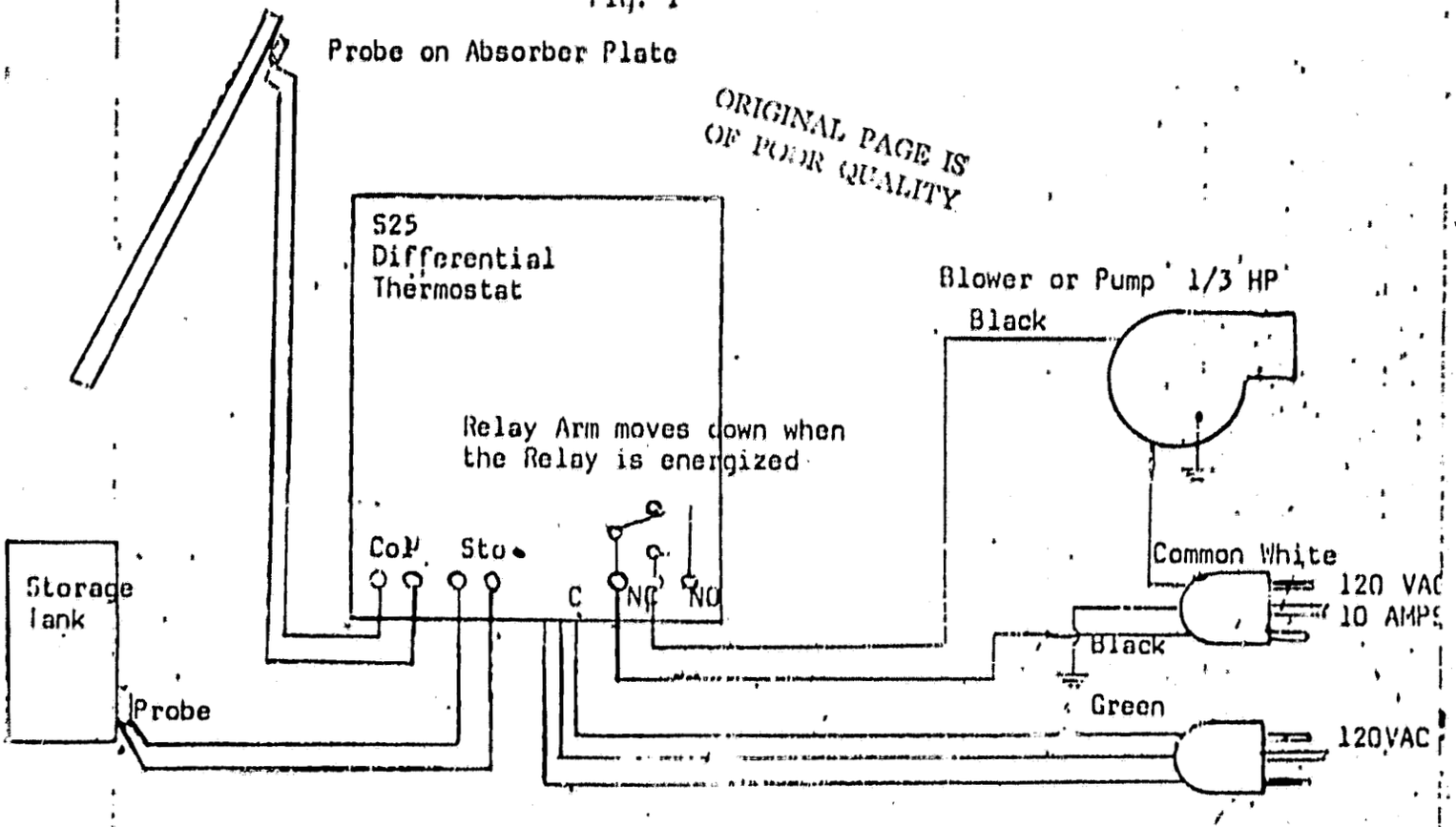
The S25, Differential Thermostats with Model numbers S25-1xx are furnished with a built-in meter for continuous monitoring of the differential temperature as well as the absolute temperatures of the collector and the storage. Select the temperature to be monitored by placing the front panel switch in the corresponding position.

Test points are provided on the circuit board so that temperatures can be measured in thermostats without a build-in meter by using a multi-meter. With leads clipped to the

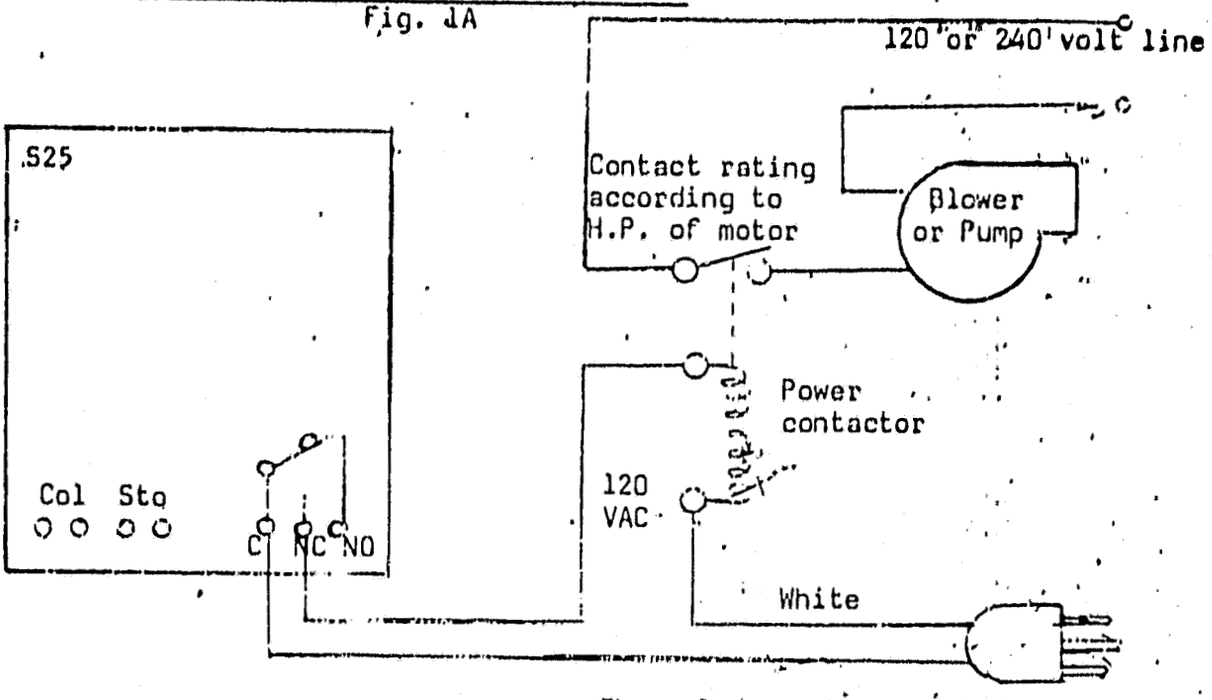
ground point located between the two terminal blocks and the "dif" point located above the left-hand terminal block, and the multi-meter set on the 10VDC setting, the meter will indicate the differential temperature directly on the appropriate scale (0-10°, 0-25°, 0-50°, depending on model purchased). Similarly, with the multi-meter clipped between ground and either the "col" point or the "sto" point, the absolute temperature of the collector or the storage, respectively, can be read on the 0-250 scale with the meter set on 10V. The use of a meter also will permit more accurate setting of the differential temperature "on" and "off" points than will the calibration marks surrounding the potentiometers.

Performance of the over-all system can be evaluated by means of the built-in meter, or a multi-meter set to indicate differential temperature. With the system in the operating mode, observe the meter indication when the pump or blower turns on at the selected "on" temperature difference. If the system is properly balanced, the differential temperature will drop slightly and then stabilize in a short time. The initial system design should indicate the amount of temperature drop to be expected. If the temperature continues to drop until the Differential Thermostat turns the motor off in a short time, say five minutes, this indicates that the transfer medium is circulating too rapidly, and the system will cycle on and off unnecessarily. If, on the other hand, the differential temperature, after an initial decrease, begins to rise again and continues to rise to a point above the pre-set "on" value, this indicates that the transfer medium is circulating at too low a rate. In either case the overall system efficiency is adversely affected and the system designer/installer should be consulted for corrective action.

NORMAL HOOKUP
Fig. 1



FOLLOWER RELAY FOR HIGHER CURRENTS
Fig. 1A



The relay can have a 24 Volt coil.
The power supply would then be a
transformer.

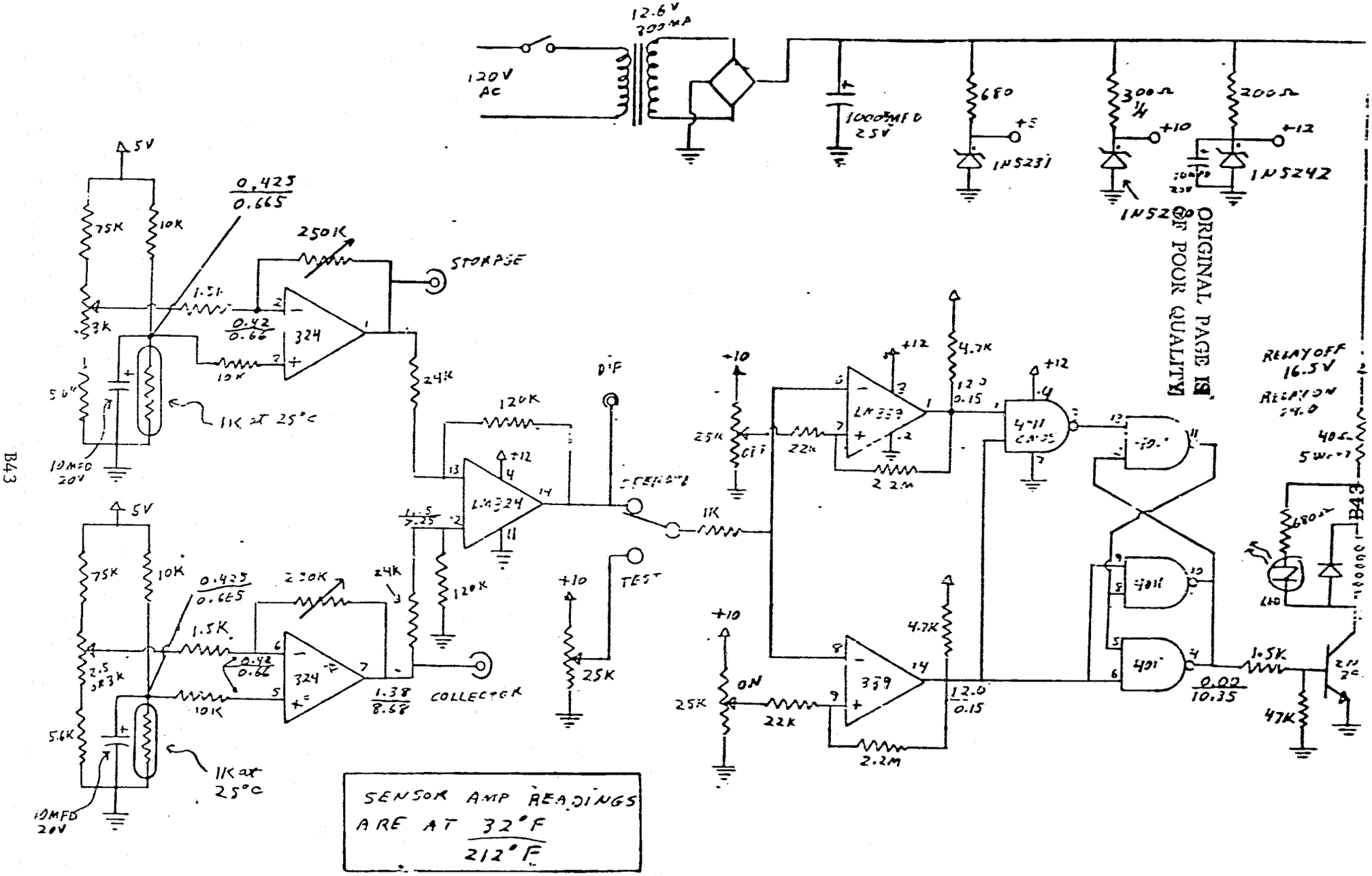
MAINTENANCE AND SERVICING

Once an S25, Differential Thermostat is properly installed and adjusted, it requires no further attention. No scheduled, routing, or preventive maintenance is required. If malfunctions occur during the Warranty period, return the unit to the dealer or distributor from whom the Thermostat was obtained. Beyond the Warranty period service can be provided by the dealer, or distributor or by an authorized service representative. In an emergency, an experienced electronic technician may be able to replace burned out or damaged parts. The circuit schematic and parts list will assist in performing this service.

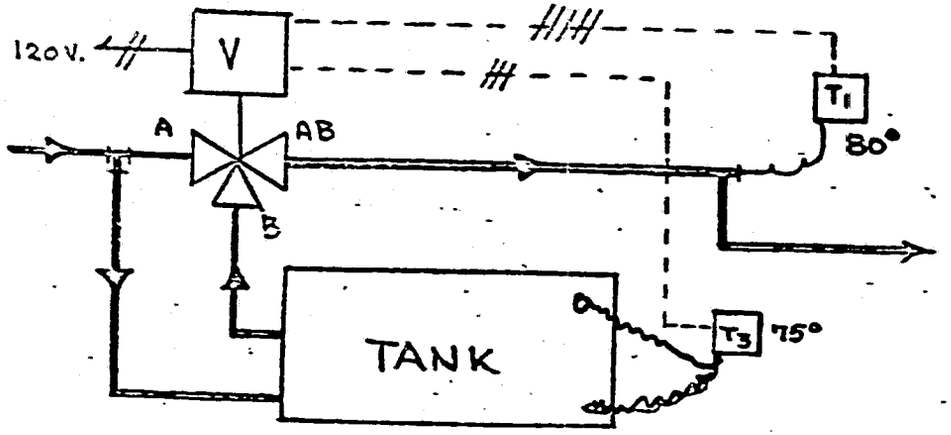
PARTS LIST

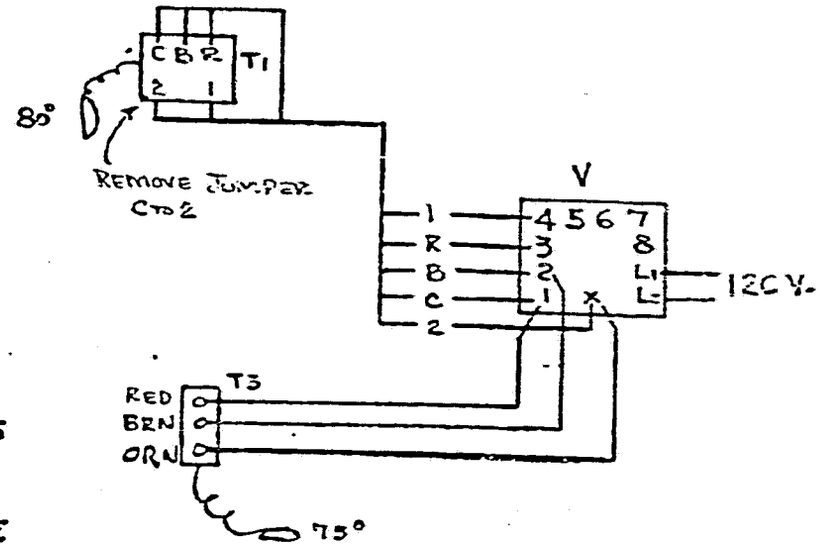
Item	Quantity	Part Name	Mfgrs. No.	Manufacturer
IC#1	1	Quad Op Amp	LM-324	National Co.
IC#2	1	Quad Comparator	LM-339	" "
IC#3	1	Quad CMOS Hand Gate	CA-4011	RCA
4	1	Relay	W88CPX-2 or W78RCSX-2	Magnacraft Corp.
5	1	12V-0.1 Amp Transformer	K12PC-1	Kaman Sciences

Equivalents are available. All other parts are common electrical/electronic components identifiable from the circuit diagram. They are available from most electronic supply houses.


12.6V 300MA
120V AC
1000MFD 25V
680
+5
1N5231
300Ω 1/4
+10
1N5242
200Ω
+12
1N5242
1N5242
5V
75K
10K
0.425
0.665
250K
STORPSE
1.5K
3K
0.42
0.66
324
10K
24K
5.6K
11K at 25°C
10MFD 20V
120K
DIF
+12
LM324
14
11
1.5
7.25
OPERATE
25K
22K
LM339
4.7K
12.0
0.15
4-11 CMOS
+10
TEST
25K
1K
RELAY OFF 16.5V
RELAY ON 14.0
40Ω 5W
680Ω
LED
1000MFD
2N2222
1.5K
47K
0.02
10.35
4011
4011
4011
5V
75K
10K
0.425
0.665
250K
24K
1.5K
2.5 OR 3K
0.42
0.66
324
10K
120K
1.38
8.68
COLLECTOR
5.6K
11K at 25°C
10MFD 20V
+10
25K
ON
22K
339
4.7K
12.0
0.15
2.2M
SENSOR AMP READINGS ARE AT 32°F 212°F
ORIGINAL PAGE IS OF POOR QUALITY
B43
B43

STORAGE TANK CONTROL





T-1 — TP 202 - BULB MICROTHERM W/WELL

T-3 — TC 1111 BULB THERMOSTAT W/WELL

V — VP 8044-103-2-14 — THREE WAY VALVE 4"

THREE WAY VALVE V IS OPERATED BY STAT T1 AND TANK STAT T3. WHEN THE TANK TEMPERATURE IS GREATER THAN 75 DEGREES, STAT T3 ALLOWS STAT T1 TO CONTROL THE THREE WAY VALVE TO MAINTAIN 80 DEGREE MIXED WATER TEMPERATURE. WHEN THE TANK TEMPERATURE DROPS BELOW 75 DEGREES, STAT T3 WILL CLOSE THE VALVE TO THE TANK.

REVISION DWG 1749-1A - ADDED CONTROL SEQUENCE. 3-28-78 WMJ

B44

JOB NAME LUTZ-SOTIRE SOLAR
LOCATION HIGH RIDGE RD. STAMFORD, CT.
ARCHITECT
ENGINEER SANFORD O. HESS
CONTRACTOR ALVAH D. JESSUP & SON, INC.

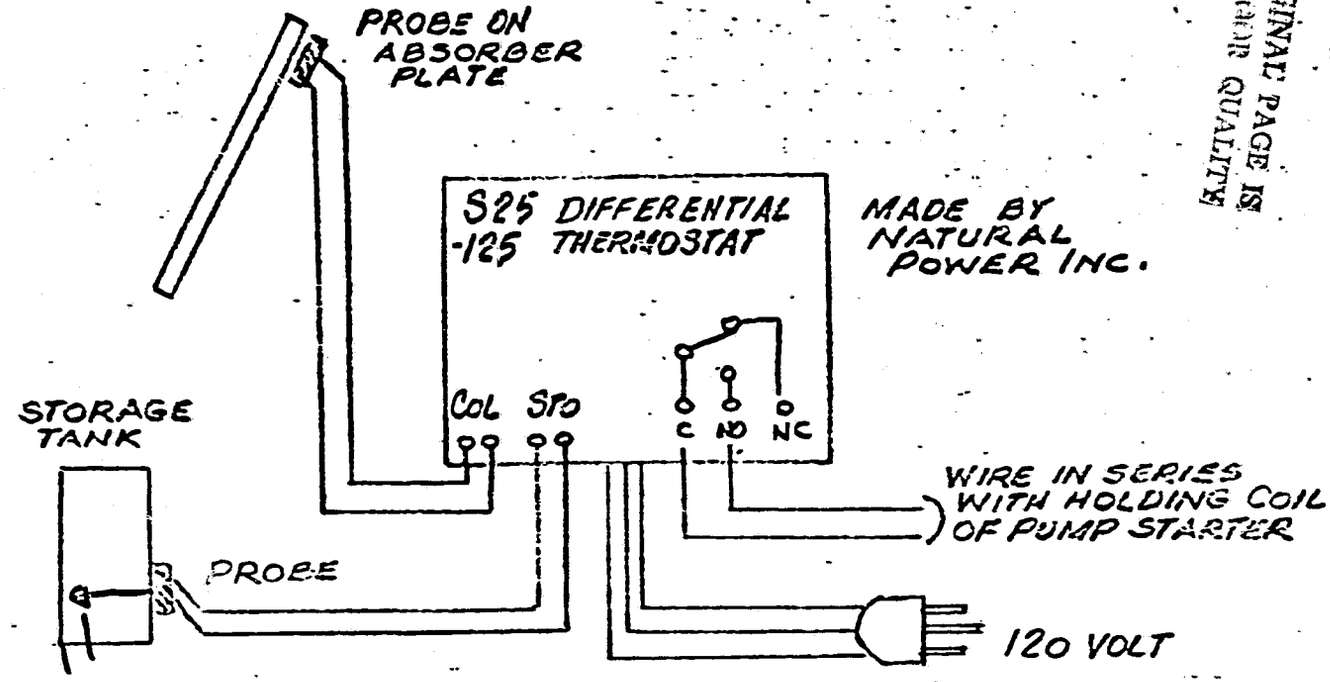
BARBER COLMAN
FIELD OFFICE

JOHNSON - GOODYER, INC.
45 BRISTOL STREET
NEW HAVEN, CONNECTICUT

DRAWN BY W.S.
CHECKED
DATE OCTOBER 18 19??

DWG. No. 1749-1A

F-3039



WHEN THE TEMPERATURE DIFFERENCE BETWEEN THE TWO PROBES IS GREATER THAN 25 DEGREES, THE PUMP WILL OPERATE. SHOULD THE DIFFERENCE DROP TO LESS THAN 12 DEGREES, THE PUMP WILL STOP.

THIS DWG. 1749A SUPERCEDES DWG. 1747

JOB NAME LUTZ - SOTIRE SOLAR LOCATION HIGH RIDGE RD. STAMFORD, CONN ARCHITECT ENGINEER SANFORD O. HESS CONTRACTOR ALVAH D. JESSUP & SON INC.	BARBER COLMAN FIELD OFFICE	JOHNSON - GOODYER INC. NEW HAVEN, CONN.
DRAWN BY WMJ CHECKED DATE 3-22-78 DWG. 1749A		

R45

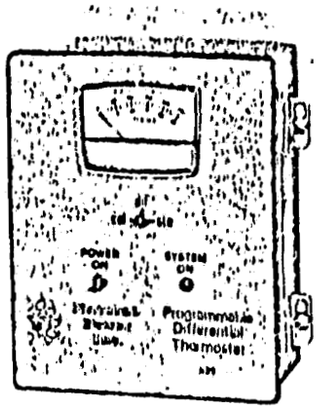
P-0039

NEW BOSTON, N. H. 03070 / 603-487-5512

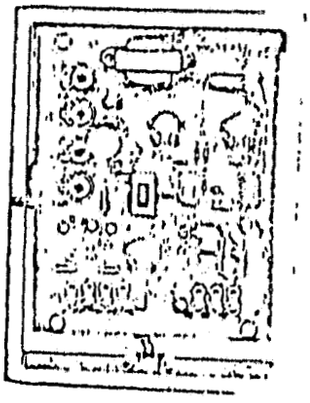
NATURAL POWER INC.

DIFFERENTIAL THERMOSTAT

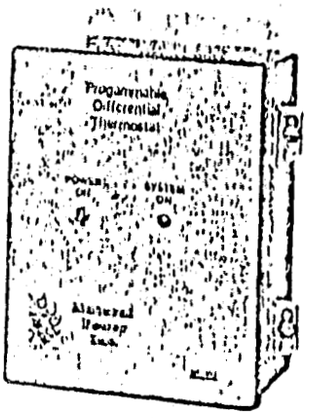
SOLAR



Model S25-125 Differential Thermostat



Model S25-050 Differential Thermostat (Internal View)



Differential Thermostat Model S25-050

Series S25 are reliable, fully adjustable devices for automatically controlling two-element solar-heated systems such as domestic hot water and swimming pools. When interfaced with the system controls (pumps, dampers, vents, and valves), they will demand system operation at the set maximum temperature differential and shut-down at the minimum. This feature ensures timely, economical transfer from collector to storage or load.

They are available with and without a front panel meter and selector switch for reading collector temperature, storage temperature, and the difference between the two.

Depending upon the model selected, the temperature differential is adjustable from zero to 10°, 25°, or 50°F. Thus, Series S25 are suitable for

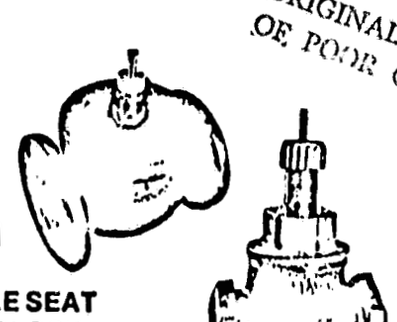
- air systems which usually require a wide differential
- liquid systems which usually require a narrow differential
- experimental and home-built systems

The single-pole double-throw relay permits control of ac heaters up to 1 kilowatt, 110 VAC motors up to ⅓ horsepower, or 220 VAC motors up to ½ horsepower. A light on the front panel indicates when this relay is energized.

The control has convenient built-in test and calibration circuitry for checking system operation by simulating temperature difference. All components are selected to ensure long life, stability, and ease of replacement. User adjustments are labeled. Internal test points are provided so that the two temperatures and difference can be monitored with a 1 MA or 10 VDC recorder or other instrument.

The Differential Thermostat is housed in an attractive, sturdy, steel cabinet and provided with two Model S90-100 Air/Surface Sensors. Model S91-100 Liquid Sensors in lieu of air sensors are available on request.

Specialists in Electronics for the Renewable Energy Industry



VB-202 SERIES ☐
VALVE BODIES
TWO-WAY, SINGLE SEAT
STEM DOWN TO CLOSE

Sizes: 1/2" to 2", 2-1/2" to 6"
Body Pattern: 1/2" to 2" Globe Screwed, 2-1/2" to 6" 125 lb. G.F.
Flow Type: 1/2" to 2" Equal Percentage, 2-1/2" to 6" Linear
Body Material: 1/2" to 2" Brass, 2-1/2" to 6" Iron
Seat Material: Brass
Stem Material: Stainless Steel
Plug Material: Brass
Disc: Composition
Stem Packing: Graphite
Max. Operating Press.—Steam: 35 psig
Max. Operating Press.—Water: 150 psig 1/2" to 2", 125 psig 2-1/2" to 6"
Recommended Diff. Press.—Steam: 25 psig*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: 138°C (281°F) Maximum
Fluid Temps.—Water: 4°C (+ 40°F) thru 149°C (300°F)
Factory Available Valve Assemblies: VA-2021, VC-2024, VP-2024, VP-2025, VU-2024

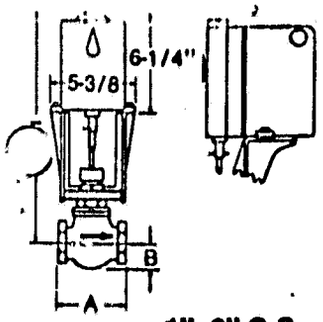
VB-804 SERIES ☐
VALVE BODIES
THREE-WAY, MIXING

Sizes: 1/2" to 2", 2-1/2" to 6"
Body Pattern: 1/2" to 2" Globe Screwed, 2-1/2" to 6" 125 lb. G.F.
Flow Type: 1/2" to 2" Mixing, 2-1/2" to 6" Mixing
Body Material: 1/2" to 2" Brass, 2-1/2" to 6" Iron
Seat Material: Brass
Stem Material: Stainless Steel
Plug Material: Brass
Disc: None
Stem Packing: Graphite
Max. Operating Press.—Steam: No Rating
Max. Operating Press.—Water: 150 psig 1/2" to 2", 125 psig 2-1/2" to 6"
Recommended Diff. Press.—Steam: No Rating*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: No Rating
Fluid Temps.—Water: 4°C (+ 40°F) thru 149°C (300°F)
Factory Available Valve Assemblies: VA-8041, VC-8044, VP-8044, VP-8045

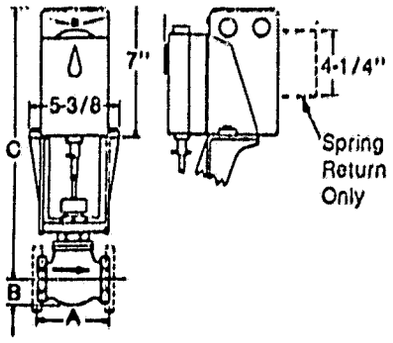
VB-212 SERIES ☐
VALVE BODIES
TWO-WAY, SINGLE SEAT
STAINLESS STEEL TRIM
STEM DOWN TO CLOSE

Sizes: 1/2" to 2"
Body Pattern: Globe Sorewed
Flow Type: Equal Percentage
Body Material: Brass
Seat Material: Stainless Steel
Stem Material: Stainless Steel
Plug Material: Stainless Steel
Disc: None
Stem Packing: Graphite
Max. Operating Press.—Steam: 150 psig
Max. Operating Press.—Water: 150 psig
Recommended Diff. Press.—Steam: 100 psig*
Recommended Diff. Press.—Water: 35 psig*
Fluid Temps.—Steam: 180°C (366°F) Maximum
Fluid Temps.—Water: 4°C (+ 40°F) thru 180°C (366°F)
Factory Available Valve Assemblies: VC-2124, VP-2124

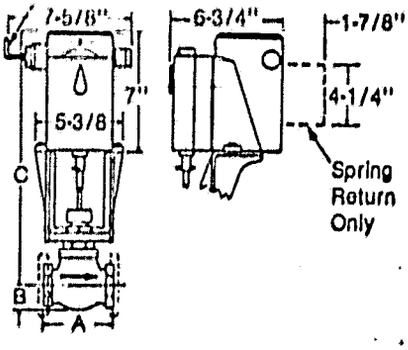
*Maximum recommended differential pressure in full open position for sizing purposes and normal life of seat and disc. **NOTE:** Do not exceed close-off rating.



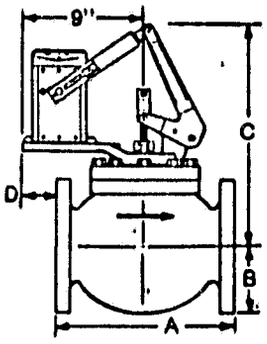
1"-2" G.S.
VA-2021



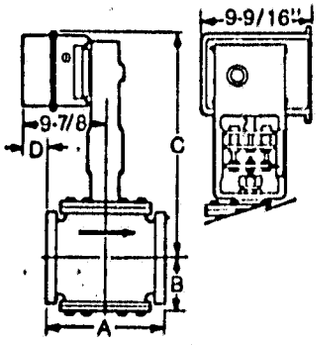
1/2"-2" G.S. 2-1/2"-4" G.F.
VC-2024, VP-2024
VC-2124, VP-2124



1/2"-2" G.S.
2-1/2"-4" G.F.
VU-2024



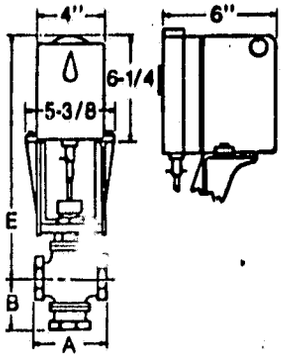
5" and 6" G.F.
VC-2024, VP-2024,



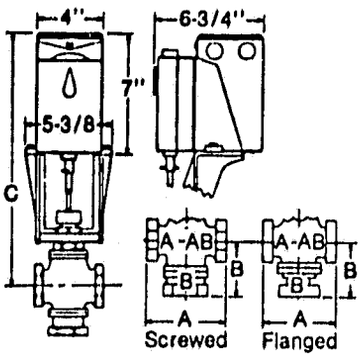
4"-6" G.F.
VP-2025

Two-Way Valves

Valve Assembly No.	Valve Size (Inches)	Dimensions (Inches)				
		A	B	C	D	E
VA-2021	1/2	2-3/4	1	15	—	—
VC-2024	3/4	3-1/8	1	15	—	—
VP-2024	1	3-3/4	1-1/4	15-1/8	—	14-3/8
VU-2024	1-1/4	4-1/4	1-3/8	15-1/4	—	14-1/2
VC-2124	1-1/2	4-5/8	1-1/2	15-7/8	—	15-1/8
VP-2124	2	6	1-7/8	16	—	15-1/4
	2-1/2	8-1/2	3-1/2	16-1/4		—
	3	9-1/2	3-3/4	16-5/8		—
	4	11-1/2	4-1/2	17-7/8		—
	5	13	5	18-1/8	3	—
	6	14	5-1/2	18-5/8	2	—
VP-2025	4	11-1/2	4-1/2	23	2	—
	5	12	6-5/8	24-1/4	3	—
	6	14-1/8	7-1/2	25-1/8	2	—



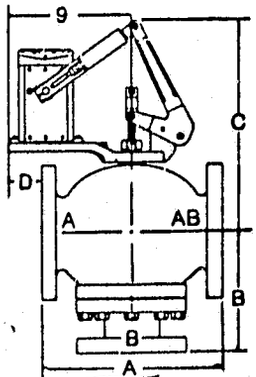
1/2"-2" G.S.
VA-8041



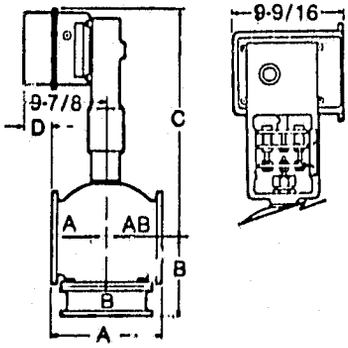
1/2"-2" G.S. 2-1/2"-4" G.F.
VP-8044 VC-8044

Three-Way Valves

Valve Assembly No.	Valve Size (Inches)	Dimensions (Inches)				
		A	B	C	D	E
VA-8041	1/2	3-1/4	2-1/2	13-5/8	—	12-7/8
VC-8044	3/4	3-1/4	2-1/2	13-5/8	—	12-7/8
VP-8044	1	3-3/4	2-5/8	13-5/8	—	12-7/8
	1-1/4	4-1/4	2-3/4	14	—	13-1/4
	1-1/2	4-5/8	2-7/8	14-1/2	—	13-3/8
	2	5-7/8	3-1/2	14-3/8	—	13-5/8
	2-1/2	8-1/2	5-3/8	15-7/8		—
	3	9-1/2	6-3/8	16-1/4		—
	4	11-1/2	8-1/2	16-7/8		—
	5	13	8-3/4	18-1/4	3	—
	6	14	9-3/4	19	2	—
VP-8045	4	11-1/2	8-1/2	22	2	—
	5	13	8-3/4	24-3/8	3	—
	6	14	9-3/4	25-1/8	2	—



4"-6" G.F.
VC-8044 VP-8044



4"-6" G.F.
VP-8045

All valves: Stem up — Flow through Port "B" to "AB"; Stem down — Flow through Port "A" to "AB".

Valve Assembly No.	Valve Size (Inches) Body	Port	Flow Coefficient Cv	Close Off Pressure Rating† Steam	Water
Spring Return or MP-2000 Actuator or Any Valve With AV-327 Linkage (AV-327 on 1/2" to 2" Valves Only)					
VA-2021, VP-2024, VU-2024	1/2	4	3.5	35	150
	3/4	7	5.8	35	150
	1	8	8.0	35	150
	1-1/4	9	15.0	35	90
	1-1/2	10	22.0	35	60
	2	11	38.0	25	25
	2-1/2	12	56	15	15
	3	13	85	10	10
	4	14	145	6	6
Non-Spring Return MP-381, MC-351 or MU-48102 Type					
VC-2024, VP-2024, VU-2024	1/2	4	3.5	35	150
	3/4	7	5.8	35	150
	1	8	8.0	35	150
	1-1/4	9	15.0	35	150
	1-1/2	10	22.0	35	140
	2	11	38.0	35	70
	2-1/2	12	56	35	40
	3	13	85	30	30
	4	14	145	16	16
	5	15	235	20	20
	6	16	350	14	14
VP-2025	MP-9710 Actuator				
	4	14	145	35	65
	5	15	200	35	40
	6	16	274	25	25
	MP-9810 Actuator				
	5	15	200	35	65
	6	16	274	35	40
Spring Return or MP-2000 Actuator or Any Valve With AV-327 Linkage (1/2" to 2" Valves Only)					
VP-2124	1/2	2	2	100	150
	1/2	3	2.8	100	150
	1/2	4	3.3	100	150
	3/4	7	5.0	100	150
	1	8	7.1	100	150
	1-1/4	9	16	90	90
	1-1/2	10	22	60	60
	2	11	37	25	25
Non-Spring Return MP-381 or MC-351 Type					
VC-2124, VP-2124	1/2	2	2	100	150
	1/2	3	2.8	100	150
	1/2	4	3.3	100	150
	3/4	7	5.0	100	150
	1	8	7.1	100	150
	1-1/4	9	16	100	150
	1-1/2	10	22	100	140
	2	11	37	70	70

†Close-off pressure ratings apply when valves are installed with pressure under the seat.

Valve Assembly No.	Valve Size (Inches) Body	Port	Flow Coefficient Cv	Close Off Pressure Ratings* Port "A"	Port "B"
Spring Return or MP-2000 Actuator or Any Valve With AV-327 Linkage (AV-327 on 1/2" to 2" Valve Only)					
VA-8041, VP-8044	1/2	4	5.1	150	150
	3/4	7	7.5	150	150
	1	8	12	150	150
	1-1/4	9	21	90	90
	1-1/2	10	32	60	60
	2	11	49	25	25
	2-1/2	12	74	15	15
	3	13	101	10	10
	4	14	169	6	6
Non-Spring Return MP-381 or MC-351 Type					
VC-8044, VP-8044	1/2	4	5.1	150	150
	3/4	7	7.5	150	150
	1	8	12	150	150
	1-1/4	9	21	150	150
	1-1/2	10	32	140	140
	2	11	49	70	70
	2-1/2	12	74	40	40
	3	13	101	30	30
	4	14	170	16	16
	5	15	290	18	18
	6	16	390	11	11
VP-8045	MP-9710				
	4	14	170	65	65
	5	15	290	40	40
	6	16	390	25	25
	MP-9810				
	5	15	290	65	65
	6	16	390	40	40

*Port "A" Rating = Inlet Pressure Port "A" minus Inlet Pressure Port "B"
Port "B" Rating = Inlet Pressure Port "B" minus Inlet Pressure Port "A"

Fluid Temperatures Versus Ambient Temperatures

Valve Assembly No.	Maximum Fluid Temperature 37°C [100°F] Ambient Steam	Water	60°C [140°F] Ambient Steam	Water
VA-2021	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VC-2024	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VP-2024	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VP-2025	138°C [281°F]	149°C [300°F]	126°C [260°F]	126°C [260°F]
VC-2124	180°C [366°F]	180°C [366°F]	126°C [260°F]	126°C [260°F]
VP-2124	180°C [366°F]	180°C [366°F]	126°C [260°F]	126°C [260°F]
VA-8041	—	149°C [300°F]	—	126°C [260°F]
VC-8044	—	149°C [300°F]	—	126°C [260°F]
VP-8044	—	149°C [300°F]	—	126°C [260°F]
VP-8045	—	149°C [300°F]	—	126°C [260°F]

TWO-POSITION VA-2021 ☐
SPRING RETURN N.O. OR N.C.
1/2" to 2" VB-202 SERIES
VALVE BODIES

For two-position control of low pressure steam or water in heating, air conditioning and industrial applications.
INPUT: Two-wire circuit, used with two-position thermostat.
OPTIONS: None

TWO-POSITION VA-8041 ☐
SPRING-RETURN
1/2" to 2" VB-804 SERIES
VALVE BODIES

For two position control of liquids in bypass applications with one outlet and two inlets.
INPUT: Two-wire circuit used with two-position thermostat.
OPTIONS: None

TWO-POSITION VC-2024 ☐
NON-SPRING RETURN
1/2" to 6" VB-202 SERIES
VALVE BODIES

For two position control of low pressure steam or water in heating, air conditioning, and industrial applications.
INPUT: Three wire circuit, snap acting switch, or equivalent, thermostat, pressure switch or relay.
OPTIONS: 1, 3

TWO-POSITION VC-2124 ☐
NON-SPRING RETURN
1/2" to 2" VB-212 SERIES
VALVE BODIES

For two-position control of steam or water in heating, air conditioning and industrial applications.
INPUT: Three wire circuit, snap acting switch, or equivalent, thermostat, pressure switch or relay.
OPTIONS: 1, 3

TWO-POSITION VC-8044 ☐
NON-SPRING RETURN
1/2" to 4" VB-804 SERIES
VALVE BODIES

For two position control of liquids in bypass applications with one outlet and two inlets.
INPUT: Three wire circuit, snap acting switch, or equivalent, thermostat, pressure switch or relay.
OPTIONS: 1, 3

PROPORTIONAL VP-2024 ☐
SPRING RETURN OR
NON-SPRING RETURN
1/2" to 6" VB-202 SERIES
VALVE BODIES

For proportional control of water or low pressure steam in heating, air conditioning and industrial applications.
INPUT: Normally controlled from TP-100 through 400 series Microtherm or a CP-8301 solid state drive.
OPTIONS: 1, 2, 3

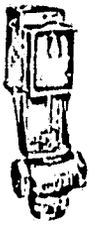
PROPORTIONAL VP-2025 ☐
NON-SPRING RETURN
" & 6" VB-202 SERIES
VALVE BODIES

For proportional control of low pressure steam or water in heating, air conditioning and industrial applications.
INPUT: Normally controlled from TP-100 through 400 series Microtherm or a CP-8301 solid state drive. MP-9810 Actuator

PROPORTIONAL VP-2124 ☐
SPRING RETURN OR
NON-SPRING RETURN
1/2" to 2" VB-212 SERIES
VALVE BODIES

For proportional control of steam or water in heating, air conditioning and industrial applications.
INPUT: Normally controlled from TP-100 through 400 series Microtherm or a CP-8301 solid state drive.
OPTIONS: 1, 2, 3

PROPORTIONAL VP-8044 ☐
SPRING RETURN OR
NON-SPRING RETURN
1/2" to 6" VB-804 SERIES
VALVE BODIES



For proportional control of liquids in mixing applications, air conditioning systems, and in hot water heating installations.
INPUT: Normally TP-100 thru 400 series Microtherm or CP-8301 solid state drive.
OPTIONS: 1, 2, 3

PROPORTIONAL VP-8045 ☐
NON-SPRING RETURN
4" to 6" VB-804 SERIES
VALVE BODIES

For proportional control of liquids on mixing applications, air conditioning systems, and in hot water heating installations.
INPUT: Normally TP-100 through 400 series Microtherm or CP-8301 solid state drive. MP-9810 Actuator requires AM-345 relay.
OPTIONS: 1, 2, 3

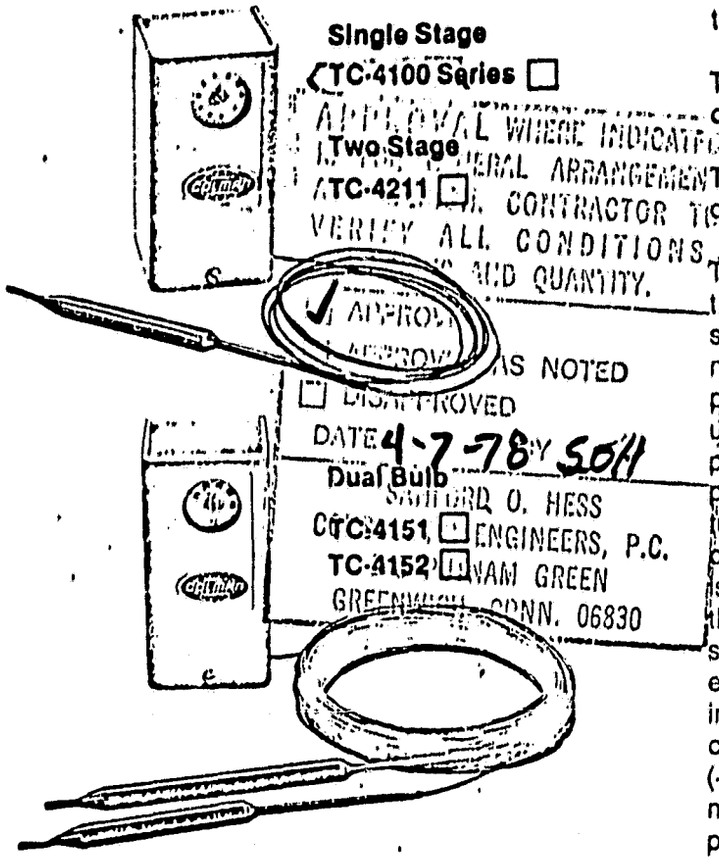
PROPORTIONAL VU-2024 ☐
SENSING BULB ATTACHED
SPRING RETURN OR
NON-SPRING RETURN
1/2" to 6" VB-202 SERIES
VALVE BODIES

For proportional control of low pressure steam or water in heating, air conditioning and industrial applications.
INPUT: Temperature sensing accomplished by built-in bulb-operated SPDT thermostat mechanism.
OPTIONS: 1, 2, 3

INSTALLATION: All valves may be mounted in upright position. For other acceptable positions see actuator general instruction sheet. Actuator can be rotated on valve bonnet and can be removed from valve as a unit.

OPTIONS:
1. **Auxiliary switch kits in two or four step versions.**
2. **Auxiliary potentiometers kits with or without two switches.**
3. **Weather-resistant gasket.**

Bulb Thermostats TC-4000 Series



Single Stage
TC-4100 Series ☐

Two Stage
TC-4211 ☐

Dual Bulb
TC-4151 ☐
TC-4152 ☐

For on-off control of media temperature in ducts, tanks, liquid lines, etc.

TC-4100 Series **one stage** units control one electrical circuit.

TC-4211 **two stage** units control two electrical circuits in sequence.

TC-4151 and TC-4152 **dual bulb units** vary the control point of the controlled media as a function of outside air temperature. One bulb senses the controlled media, the second bulb senses the outside air temperature. The ratio specified is outdoor to indoor. A unit with a 1 to 1-1/2 ratio will increase the water temperature 1-1/2°F for a 1°F decrease in outdoor temperature. **Device:** Liquid filled thermal element actuates one snap acting SPDT switch per stage. Large color coded terminals. Setpoint adjustment dial plate is marked in °F on one side and °C on the other. The thermal differential is adjustable within the limits shown in the performance table. The mechanism is enclosed in a metal case and the cover, and has 1/2-inch to 3/4-inch conduit opening in the bottom of the case. The ambient rating at the case is –40 to 60°C (–40 to 140°F). Remote bulbs are suitable for immersion, duct, or outside air mounting. **Outputs:** See performance table. **Options:** Setpoint concealment plate if required. Order AT-210.

Duct Mounting Kit
AT-208 ☐

Bulb Mounting Kit
AT-209 ☐

Concealed Adj. Plate
AT-210 ☐

Bulb Mounting Accessories: (Order Separately)

Description	Ordering Number
Duct Mounting Kit	AT-208
Liquid Line, Tank with or without Bulb Well. A Bulb Well is recommended	AT-209
Outside Bulb Shield	AT-211
Bulb Wells	AT-201 Copper
	AT-203 Stainless

Electrical Rating: All Units Except TC-4115

Switch Rating (50/60 Hz)	24V	120V	240V	277V
Full Load Amps	—	9.8	8.0	—
Locked Rotor Amps	—	58.8	48.0	—
Pilot Duty VA	60	360	360	—
Non-Inductive Amps (Resistive)	—	—	—	—
Single Stage	22	22	22	22
Two Stage	16	16	8.3	7.2

Performance and Selection Table

Type	Part Number	Set Point Adjustment Range °C (°F)	Dual Bulb Ratio	Dimensions			Differential	
				Capillary Copper	Bulb Copper		Factory Set	Adjustable
Single Stage	TC-4111	-40 to 49 (-40 to 120)		1.8M (6')	10 x 100 mm (3/8 x 4")		1.6°C (3°F)	1.6 to 8.5°C (3 to 16°F)
	TC-4111-020			6M (20')				
	TC-4115*			1.8M (6')				
	TC-4121			3M (10') Armored				
	TC-4122	38 to 127 (100 to 260)						
	TC-4123	88 to 176 (190 to 350)						
Dual Bulb	TC-4151	21 to 49 (70 to 120)	1:1½ **	9M (30') Each Bulb	Outdoor: 10 x 100 mm (3/8 x 4")	Indoor: 10 x 140 mm (3/8 x 5½")	1.6°C (3°F)	.8 to 5.5°C (1½ to 10°F)
	TC-4152		1:1		10 x 100 mm (3/8 x 4")	10 x 100 mm (3/8 x 4")		1.6 to 8.5°C (3 to 16°F)
Two Stage	TC-4211	-40 to 49 (-40 to 120)		1.8M (6')	10 x 100 mm (3/8 x 4")		1.6°C (3°F)	Per Stage Fixed Between Stages 1.1 to 5.5°C (2 to 10°F)

*TC-4115 for System 8000 and dry circuit switching. Electrical Rating: 1.0 amp at 24 Vac; .25 Amp at 24 Vdc.
**TC-4151 — For 1½ : 1 ratio reverse bulbs and use extra dial supplied with unit.

For Dual Bulb:

To select Ratio it is necessary to know only: (1) Outdoor design temperature, (2) Maximum water temperature at outdoor design temperature, and (3) Desired water temperature at 70°F outdoors.

Example Select ratio for panel installation with a -10°F design temperature and estimated supply water temperatures of 75°F at 70°F outdoors, and 125°F at -10°F outdoors.

From chart below, -10°F for 1½ to 1 ratio, note by interpolation (70°F to 123°F with dial at 70°F; 80°F to 133°F with dial at 80°F) that water temperature varies from 75°F to 128°F as outdoor temperature drops from 70°F to -10°F, when dial is set at 75°F.

By similar means, note that a control with 1 to 1 ratio would result in water temperatures varying from 75°F to 155°F. For this application the 1½ to 1 ratio should be selected.

Outdoor Temperature (F)	Ratio	Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70°F to Design Temperature					
		Dial Set at 70°F	Dial Set at 80°F	Dial Set at 90°F	Dial Set at 100°F	Dial Set at 110°F	Dial Set at 120°F
-30	1 to 1½	70 to 220	80 to 230	90 to 240	100 to 250	110 to 260	120 to 270
	1 to 1	70 to 170	80 to 180	90 to 190	100 to 200	110 to 210	120 to 220
	1½ to 1	70 to 137	80 to 147	90 to 157	100 to 167	.....	.....
-20	1 to 1½	70 to 205	80 to 215	90 to 225	100 to 235	110 to 245	120 to 255
	1 to 1	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1½ to 1	70 to 130	80 to 140	90 to 150	100 to 160	.....	.....
-10	1 to 1½	70 to 190	80 to 200	90 to 210	100 to 220	110 to 230	120 to 240
	1 to 1	70 to 150	80 to 160	90 to 170	100 to 180	110 to 190	120 to 200
	1½ to 1	70 to 123	80 to 133	90 to 143	100 to 153	.....	.....
0	1 to 1½	70 to 175	80 to 185	90 to 195	100 to 205	110 to 215	120 to 225
	1 to 1	70 to 140	80 to 150	90 to 160	100 to 170	110 to 180	120 to 190
	1½ to 1	70 to 117	80 to 127	90 to 137	100 to 147	.....	.....
+10	1 to 1½	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 to 1	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1½ to 1	70 to 110	80 to 120	90 to 130	100 to 140	.....	.....
+20	1 to 1½	70 to 145	80 to 155	90 to 165	100 to 175	110 to 185	120 to 195
	1 to 1	70 to 120	80 to 130	90 to 140	100 to 150	110 to 160	120 to 170
	1½ to 1	70 to 103	80 to 113	90 to 123	100 to 133	.....	.....
+30	1 to 1½	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 to 1	70 to 110	80 to 120	90 to 130	100 to 140	110 to 150	120 to 160
	1½ to 1	70 to 97	80 to 107	90 to 117	100 to 127	.....	.....

Room Microtherms

TP-101 ☐
TP-135 ☐

Bulb Microtherms

TP-200 Series ☐
TP-307 ☐
TP-402 ☐

For proportional control of room temperature, using Barber-Colman proportional actuators and sequence controllers. **Device:** Sturdy bakelite base and die cast cover. Bimetal thermometer indicates 10° to 32°C (50° to 90°F). Large setpoint adjustment wheel is clearly marked and includes feature for limiting the minimum and maximum setpoint for energy management. Large coded, screw-type terminals. Fast responding bimetal control element. SPDT switch with silver contacts. Built-in circuitry conditions the actuator feedback voltage for proportional control. The TP-135 has a built-in night depression resistance heater which allows control at a lower room temperature. 10° night depression is standard and normal control is from a centrally located time switch. **Output:** See table for performance data. Four-wire circuit drives one proportional Barber-Colman actuator. Additional actuators require a potentiometer and an AE-504 paralleling kit each. **Options:** Cover styles available without thermometers and or concealed adjustment. AT-101 lock cover kit, and AT-1100 series thermostat guards. **Ordering:** Device is complete with mounting screws.

Room Microtherms

Part No.	Description	Adjustment Scale °C (°F)	Differential °C (°F)	Throttling Range °C (°F)	Switch Rating at 24 Vac Only (Amps)
TP-101	Standard 24 Vac Microtherm	13 to 29 (55 to 85)	.5 (1)	2.2 (4)	1.0
TP-135	With Night Depression	13 to 29 (55 to 85)	.5 (1)	2.2 (4)	1.0

For proportional control of media temperatures in ducts, plenum chambers, liquid lines, tanks, etc. Used with Barber-Colman proportional actuators. **Device:** Metal case with 13 mm (1/2-inch) conduit opening at top and bottom. Graduated adjusting knob, with recessed locking screw. SPDT switch and solenoid mounted on printed circuit board. Built-in arc-suppressor. A 19 mm (3/4-inch) water tight fitting is included for thermal element. **Input:** Feedback voltage from actuator to solenoid. Joint action of bulb and solenoid controls switch action. **Output:** Differential is 1-1/2°F, factory set. SPDT neutral center switch, rated 24 Vac, 1 amp, provides proportional positioning of actuator. **Options:** Capillary tubing in 6m or 14m (20 or 45 foot) lengths. Also coiled or averaging bulb styles. **Order** bulb wells of copper (AT-201) or stainless steel (AT-203) separately for 10 mm x 241 mm (3/8 x 9-1/2-inch) bulbs.

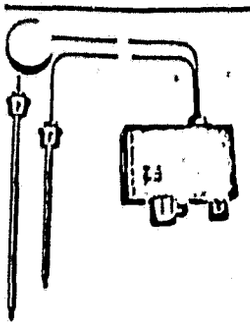
Bulb Microtherms

Part No.	Scale °C (°F)	Throttling Range °C (°F) Factory Set	Throttling Range °C (°F) Adjustable	Max. Safe Bulb Temp. °C (°F)	Capillary	Typical Applications	Bulb Dimensions MM (Inches)	Case Dimension MM (Inches)
TP-201	–40 to 4 (–40 to 40)	5.0 (9)	2.2 to 6.6 (4 to 12)	88 (190)	1.8m (6') Copper	Low Temperature	10 x 241 (3/8 x 9-1/2)	95 H x 133 W x 48 D (3-3/4 H x 5-1/4 W x 1-7/8 D)
TP-202	–12 to 32 (10 to 90)	2.2 (4)	2.2 to 6.6 (4 to 12)	110 (230)	1.8m (6') Copper	Return Air or Chilled Water		
TP-204	38 to 82 (100 to 180)	5.0 (9)	2.2 to 6.6 (4 to 12)	160 (320)	1.8m (6') Copper	Hot Water or Warm Air		
TP-205	66 to 110 (150 to 230)	5.0 (9)	2.2 to 6.6 (4 to 12)	160 (320)	1.8m (6') Copper	Hot Water or Warm Air		
TP-209	10 to 54 (50 to 130)	2.2 (4)	2.2 to 6.6 (4 to 12)	110 (230)	1.8m (6') Copper	Condenser Water		
TP-221	–17 to 71 (0 to 160)	8.0 (15)	2.8 to 14 (5 to 25)	110 (230)	3m (10') Armored	Process Control		
TP-222	32 to 121 (90 to 250)	8.0 (15)	2.8 to 14 (5 to 25)	160 (320)	3m (10') Armored	Process Control		
TP-223	88 to 176 (190 to 350)	8.0 (15)	2.8 to 14 (5 to 25)	216 (420)	3m (10') Armored	Process Control		
TP-307*	10 to 54 (50 to 130)	8.0 (15)	2.8 to 14 (5 to 25)	110 (230)	1.8m (6') Copper	Low Limit Fan Discharge	19 x 190 (3/4 x 7-1/2)	
TP-402	–12 to 32 (10 to 90)	5.0 (9)	2.2 to 6.6 (4 to 12)	110 (230)	1.8m (6') Copper	Mixed Air	5 x 1320 (3/16 x 52)	

*Unit has split tongue which enables it to call for heat regardless of the temperature of the pilot microtherm.

Dual Bulb Microtherms
TP Series

Product Information



Dual Bulb
Fixed Ratio Microtherms

TP-230 Series ☐

For proportional actuator control of media in ducts, plenums, supply pipes, etc., to vary temperature as a function of outside air temperature. The ratio specified is outdoor to indoor. A unit with 1 to 1-1/2 ratio increases the water temperature 1-1/2°F for a 1°F decrease in outdoor temperature. **Device:** Die cast case with 13 mm (1/2-inch) conduit knockouts, top and bottom, and metal cover. Graduated adjusting knob with recessed locking screw, indicates control setting at 21°C (70°F) outdoors. Large coded terminals. 19 mm (3/4-inch) water tight thermal element fitting on indoor and a protective metal shield on outdoor. **Output:** For 24 volt, 60 Hz control circuit. Contact rating 1.0 amps. **Options:** 14m (45-foot) capillary and coiled, straight or averaging bulbs. Immersion bulb wells (copper) AT-201 for 10 mm x 241 mm (3/8-inch x 9-1/2-inch) and AT-202 for 6 mm x 337 mm (3/8-inch x 13-1/4-inch). Stainless steel AT-203 for 10 mm x 241 mm (3/8-inch x 9-1/2-inch). **Ordering:** Devices are complete including immersion fitting, outdoor metal shield and shield bulb clip.

To Select Ratio it is necessary to know only: (1) Outdoor design temperature, (2) Maximum water temperature at outdoor design temperature, and (3) Desired water temperature at 70°F outdoors.

Example Select ratio for panel installation with a -10°F design temperature and estimated supply water temperatures of 75°F at 70°F outdoors, and 125°F at -10°F outdoors.

From graph below, -10°F for 1-1/2 to 1 ratio, note by interpolation (70°F to 123°F with dial at 70°F; 80°F to 133°F with dial at 80°F) that water temperature varies from 75°F to 128°F as outdoor temperature drops from 70°F to -10°F, when dial is set at 75°F.

By similar means, note that a control with 1 to 1 ratio would result in water temperatures varying from 75°F to 155°F.

For this application the 1-1/2 to 1 ratio should be selected.

Performance Data

Part No	Adjustment Scale °C (°F)	Ratio	Bulb Dimensions MM (Inches)		Throttling Range °C (°F)	
			Outdoor	Indoor	Factory Set	Adjustable
TP-231	21 to 54 (70 to 130)	1 to 1-1/2	10 x 285 (3/8 x 11-1/4)	10 x 210 (3/8 x 8-1/4)	8.0 (15)	2.8 to 14.0 (5 to 25)
TP-232	15 to 49 (60 to 120)	1 to 1	10 x 241 (3/8 x 9-1/2)	10 x 241 (3/8 x 9-1/2)	5.0 (9)	2.2 to 6.6 (4 to 12)
TP-233	15 to 38 (60 to 100)	1-1/2 to 1	10 x 210 (3/8 x 8-1/4)	10 x 285 (3/8 x 11-1/4)	5.0 (9)	2.2 to 6.6 (4 to 12)

Capillary lengths: Indoor is 5m (15'). Outdoor is 9m (30').

Outdoor Temperature (F)	Ratio	Change in Water Temperature for Different Ratios as Outdoor Temperature Drops from 70F to Design Temperature					
		Dial Set at 70F	Dial Set at 80F	Dial Set at 90F	Dial Set at 100F	Dial Set at 110F	Dial Set at 120F
-30	1 to 1-1/2	70 to 220	80 to 230	90 to 240	100 to 250	110 to 260	120 to 270
	1 to 1	70 to 170	80 to 180	90 to 190	100 to 200	110 to 210	120 to 220
	1-1/2 to 1	70 to 137	80 to 147	90 to 157	100 to 167	—	—
-20	1 to 1-1/2	70 to 205	80 to 215	90 to 225	100 to 235	110 to 245	120 to 255
	1 to 1	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1-1/2 to 1	70 to 130	80 to 140	90 to 150	100 to 160	—	—
-10	1 to 1-1/2	70 to 190	80 to 200	90 to 210	100 to 220	110 to 230	120 to 240
	1 to 1	70 to 150	80 to 160	90 to 170	100 to 180	110 to 190	120 to 200
	1-1/2 to 1	70 to 123	80 to 133	90 to 143	100 to 153	—	—
0	1 to 1-1/2	70 to 175	80 to 185	90 to 195	100 to 205	110 to 215	120 to 225
	1 to 1	70 to 140	80 to 150	90 to 160	100 to 170	110 to 180	120 to 190
	1-1/2 to 1	70 to 117	80 to 127	90 to 137	100 to 147	—	—
+10	1 to 1-1/2	70 to 160	80 to 170	90 to 180	100 to 190	110 to 200	120 to 210
	1 to 1	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1-1/2 to 1	70 to 110	80 to 120	90 to 130	100 to 140	—	—
+20	1 to 1-1/2	70 to 145	80 to 155	90 to 165	100 to 175	110 to 185	120 to 195
	1 to 1	70 to 120	80 to 130	90 to 140	100 to 150	110 to 160	120 to 170
	1-1/2 to 1	70 to 103	80 to 113	90 to 123	100 to 133	—	—
+30	1 to 1-1/2	70 to 130	80 to 140	90 to 150	100 to 160	110 to 170	120 to 180
	1 to 1	70 to 110	80 to 120	90 to 130	100 to 140	110 to 150	120 to 160
	1-1/2 to 1	70 to 97	80 to 107	90 to 117	100 to 127	—	—

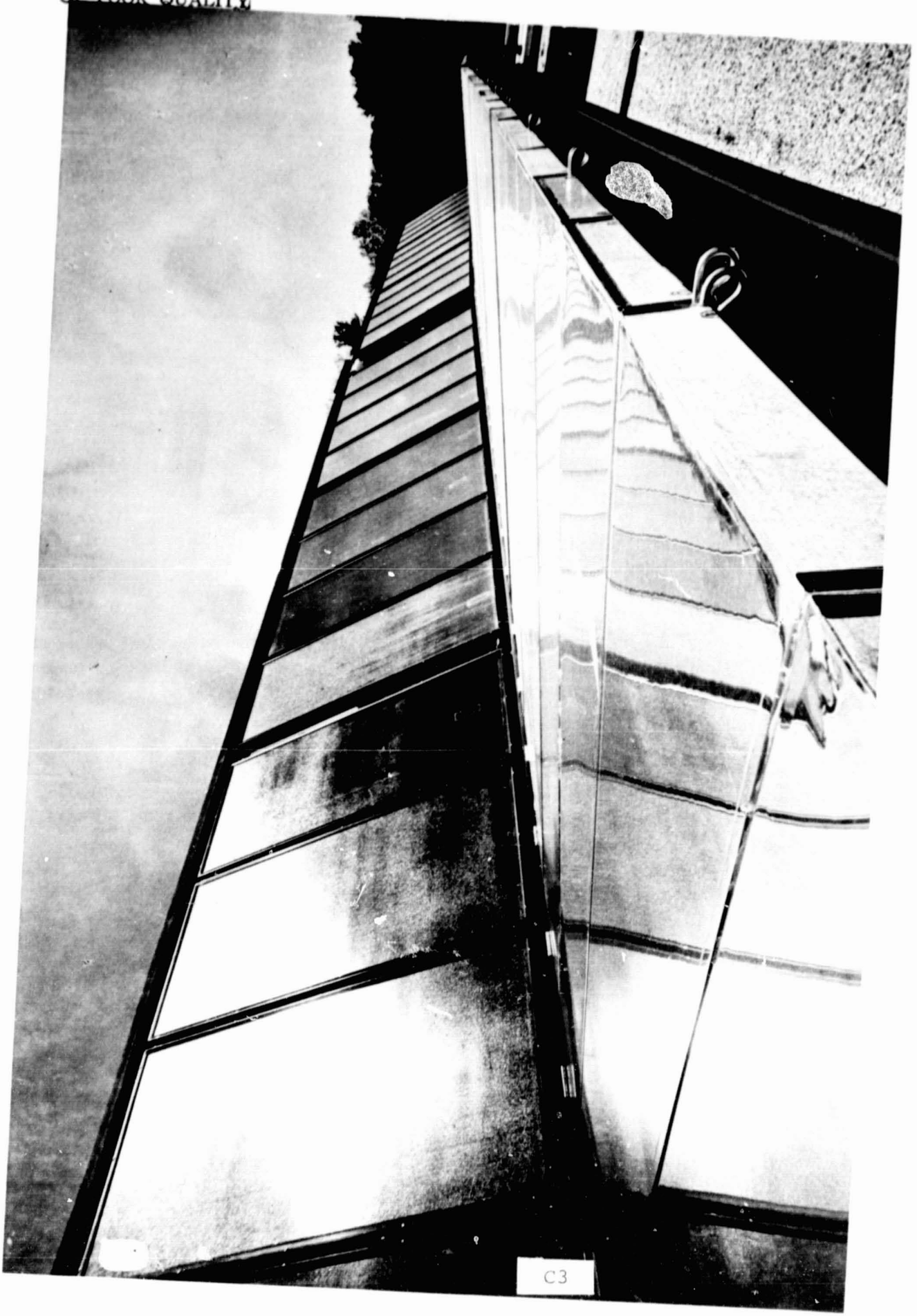
Barber-Colman Company
CONTROLS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

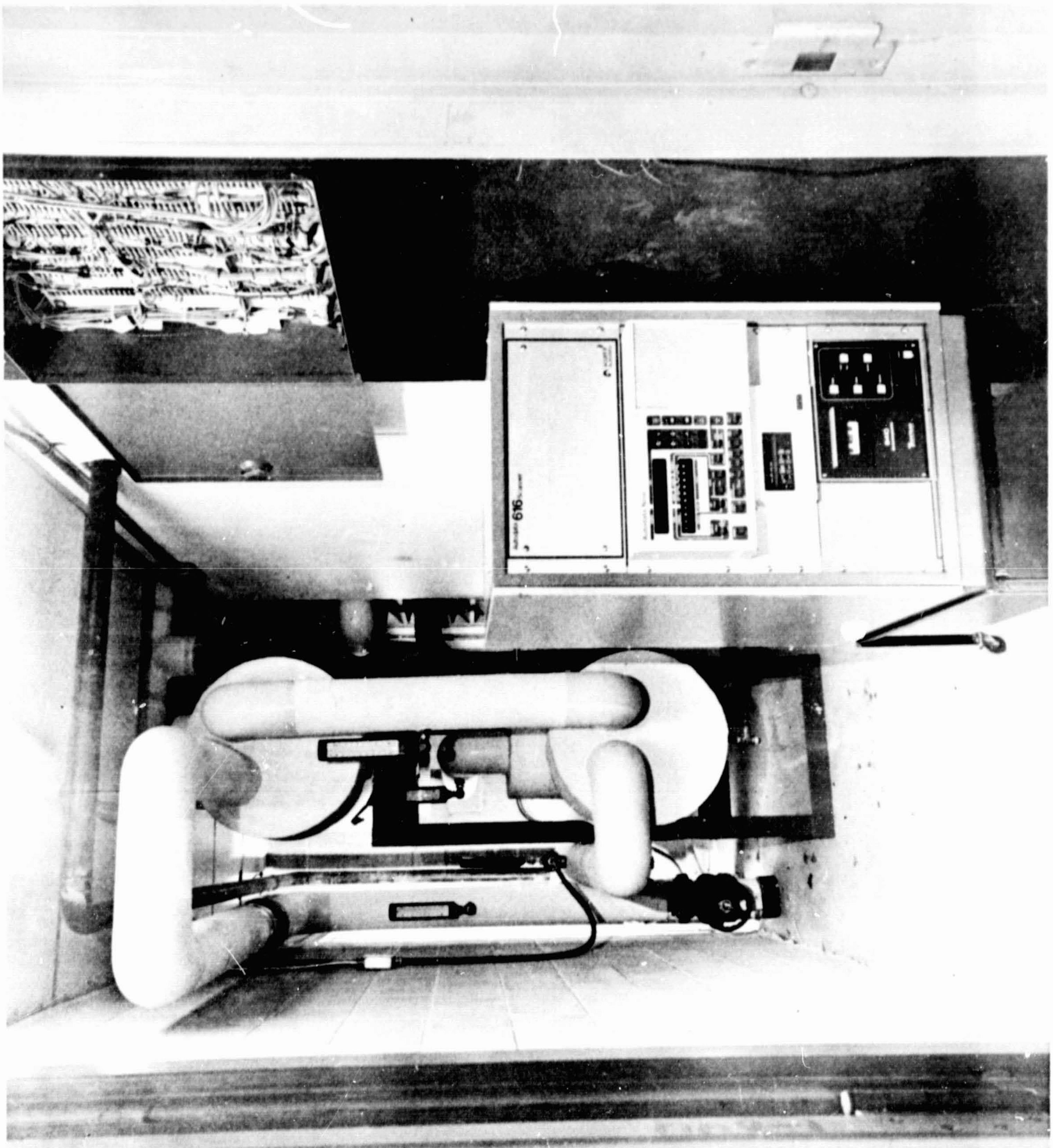
MAINTENANCE SCHEDULE

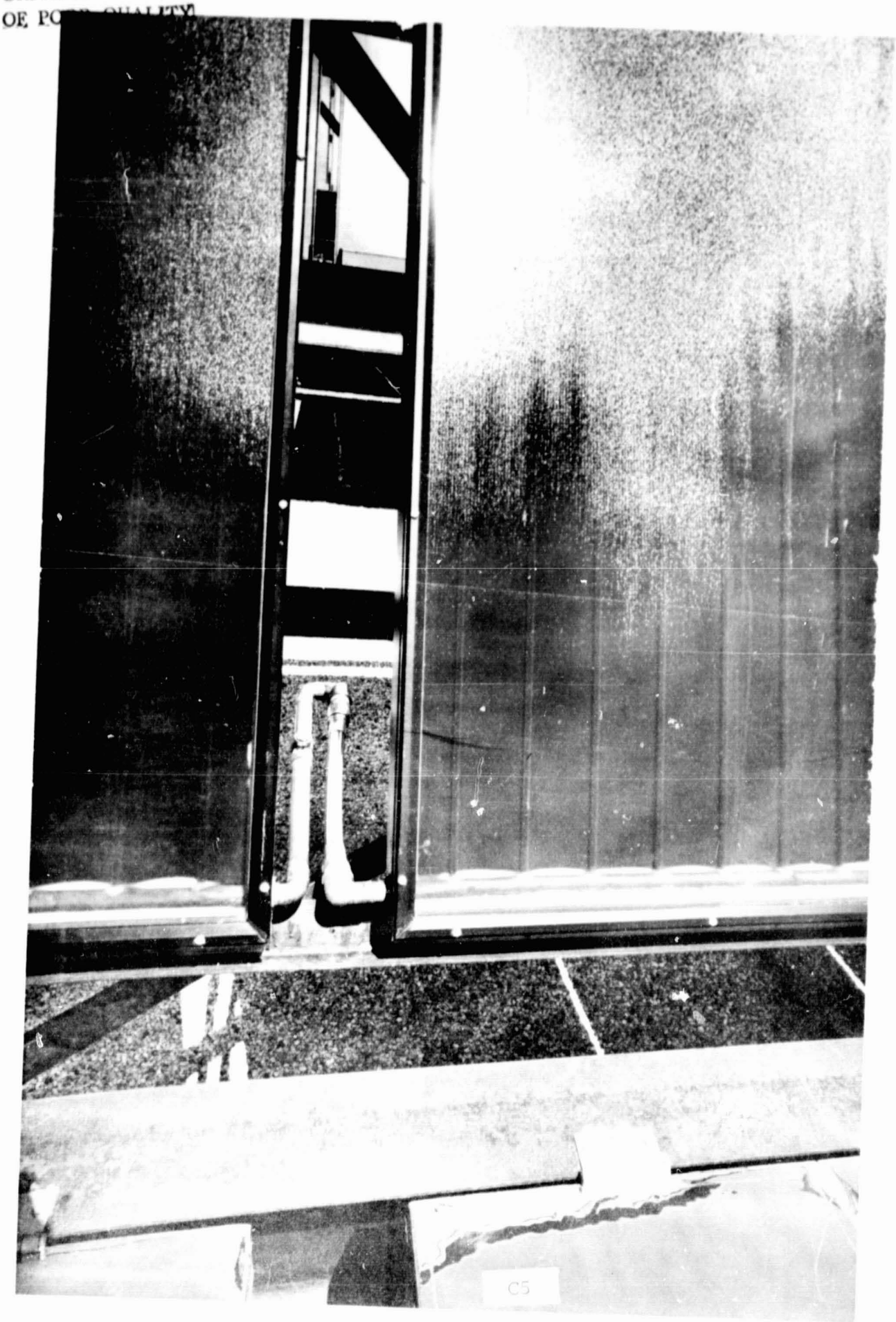
Component	Frequency	Inspect	Clean	Adjust	Lubricate	Replace
Collectors	Semi-annually	X	As required			
Reflectors	Semi-annually	X	"	X		
Support Structure	Annually	X				
Pumps	Annually				X	
Heat Exch.	Semi-annually	X	As required			
Anti freeze	Semi-annually	X				As required
Inhibitors	Semi-annually	X				"
Storage Water	Semi-annually	X				"
Pressure Reliefs	Annually	X				
Strainers	Semi-annually	X	As required			
Controls	Annually	X				
Diff. Control.	Annually	X				
3 way Valves	Annually	X				
Insulation	Annually	X				
Valve Positioning	Annually	X				
Expansion Tank Level	Semi-annually	X				

APPENDIX C

AS-BUILT DRAWINGS AND PHOTOGRAPHS







SOLAR RETROFIT

EXECUTIVE EAST

OFFICE

STAMFOR

FOLDOUT FRAME

ERDA

FIT

ST

FICE BUILDING

AMFORD, CONN.

FOLDOUT FRAME 2

ERDA CONTRACT E 49-18-2377

WORMSER SCIENTIFIC CORP.
[illegible] FOXWOOD RD., STAMFORD, CONN. [illegible] PHONE [illegible]

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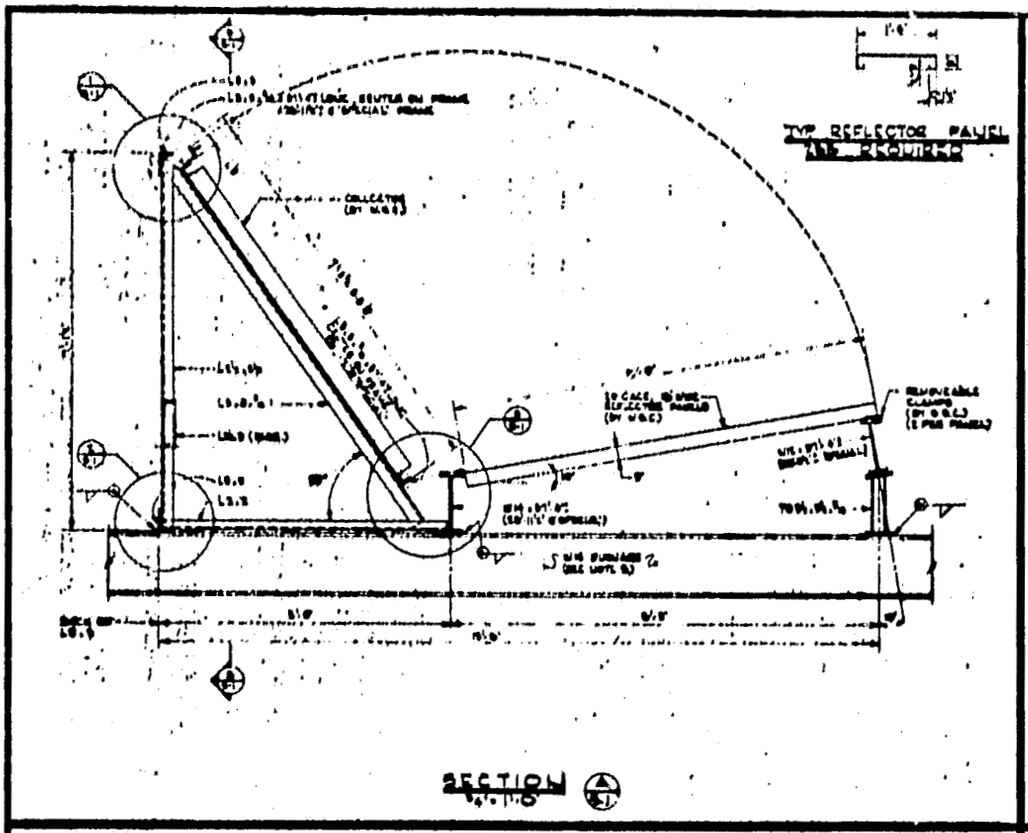

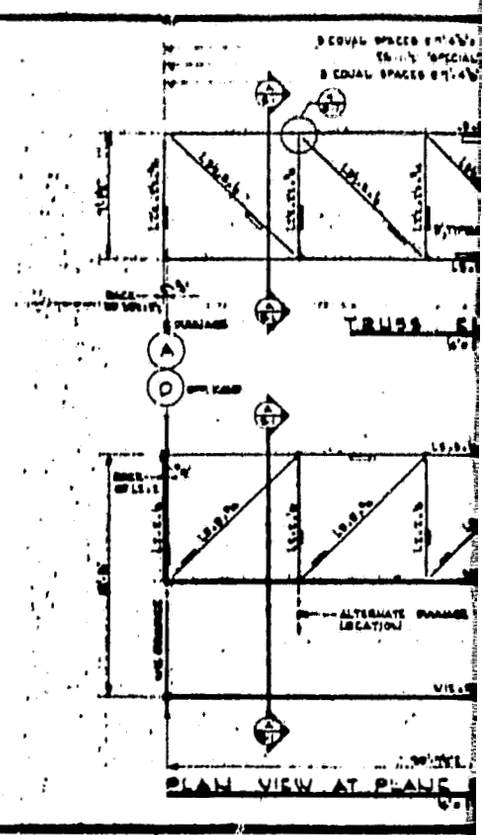

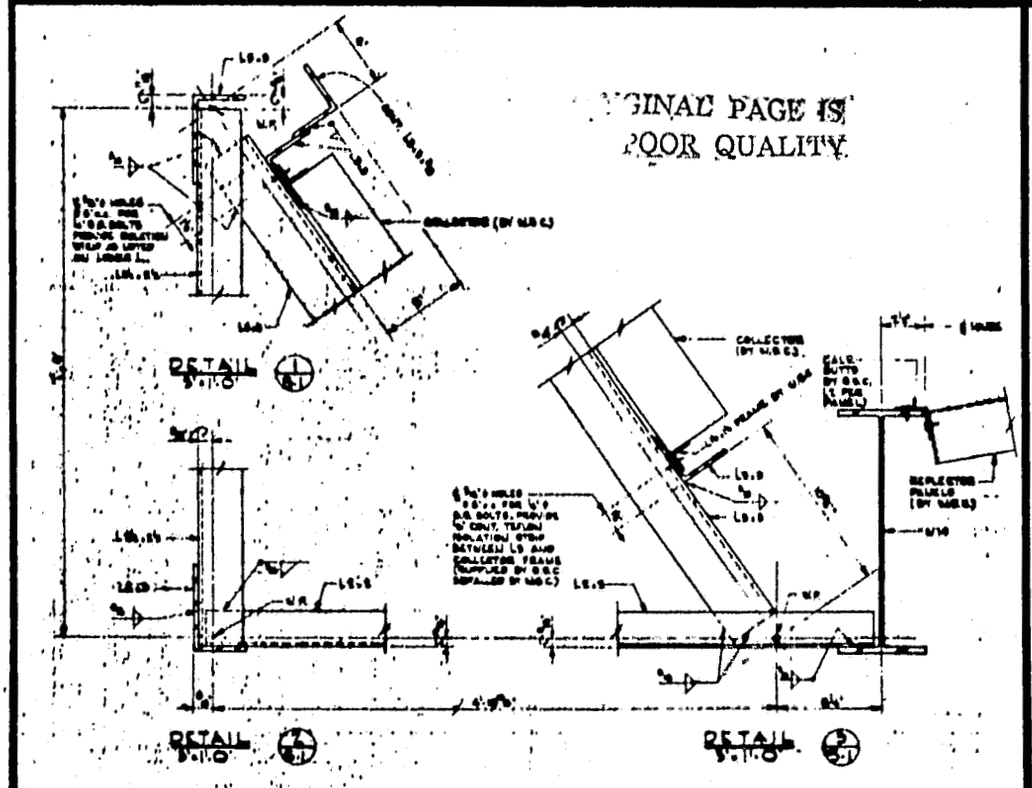

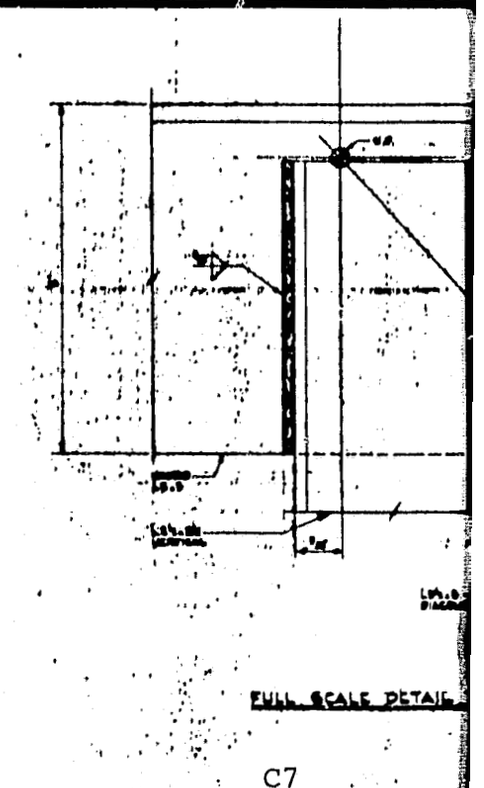

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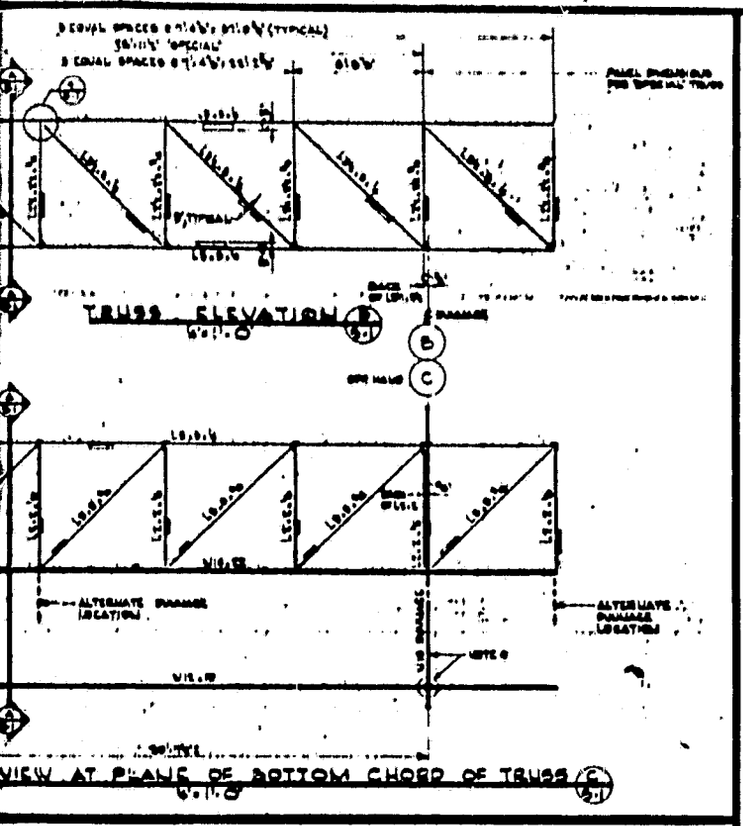

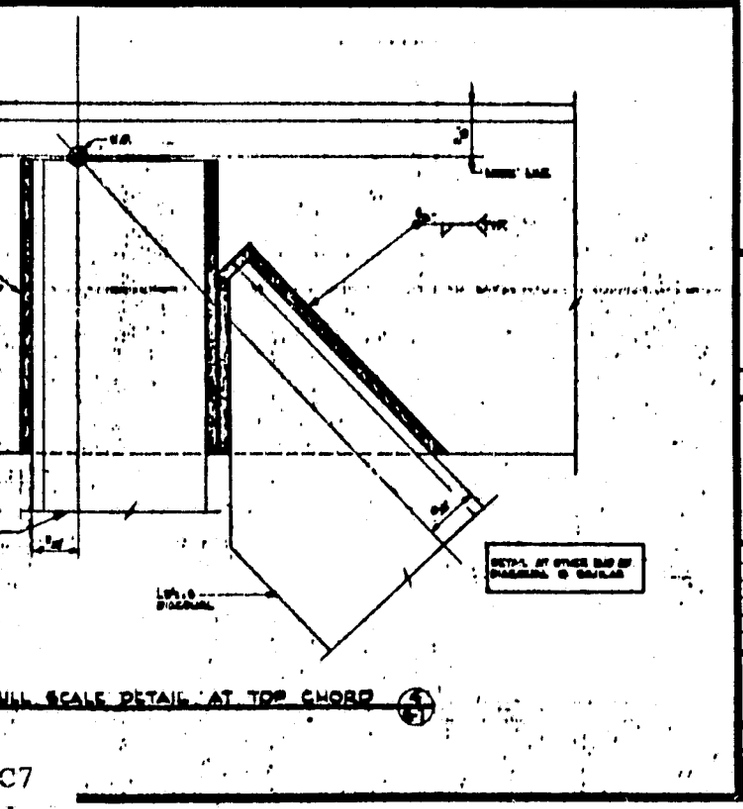

NOTES AND SPECIFICATIONS

1. THE PURPOSE OF THIS PROJECT IS TO PROVIDE A FRAME, MADE TO SUPPORT COLLECTOR AND REFLECTOR COMPONENTS OF A SOLAR ENERGY HEATING SYSTEM TO BE INSTALLED AT 1011 HIGH RIDGE ROAD, STAMFORD, CONNECTICUT.

2. THE FRAME REPORTED IS TYPICAL OF 15 - W/O TYPE, AS SHOWN. THE OTHER FRAMES, WITHOUT EXTENSIONS ARE ALSO REQUIRED. SEE THE DRAWINGS REFERRED TO IN NOTE 3, BELOW FOR THE LOCATION AND ARRANGEMENT OF THESE FRAMES.

3. THE SOLAR SYSTEM IS TO BE INSTALLED BY HARRIS SCIENTIFIC CORPORATION OF STAMFORD, CONNECTICUT. SEE THEIR DRAWINGS FOR DETAILS OF THEIR ESW PANEL.

4. THE SUNSAVER BEAMS INSTALLED ON THIS DWELLING ARE A PART OF A D HOME SYSTEM DESIGNED BY THE OFFICE OF BIGGS DOWNTON & ASSOCIATES, CONSULTING ENGINEERS, STAMFORD, CONNECTICUT. SEE THEIR DRAWING FOR DETAILS OF THIS SYSTEM.

5. THE WORK SHOWN ON THIS PLAN HAS BEEN DESIGNED IN ACCORDANCE WITH THE BASIC BUILDING CODE OF THE STATE OF CONNECTICUT FOR THE FOLLOWING LOADS:

SNOW @	30 PSF
COLLECTORS OR REFLECTORS @	5 PSF
STRUCTURAL STEEL @	10 PSF

IN ADDITION THE FRAMING HAS BEEN DESIGNED FOR A WIND LOAD OF 20 PSF AGAINST THE VERTICALLY PROJECTED SURFACE OF THE COLLECTOR.

6. ALL STRUCTURAL STEEL FOR THIS WORK SHALL CONFORM TO ASTM A588, A HIGH-STRENGTH LOW ALLOY "WEATHERING" STEEL HAVING ENHANCED ATMOSPHERIC CORROSION RESISTANCE.

7. ALL STEEL-TO-STEEL CONNECTIONS ARE TO BE FIELD WELDED SHOP WELDED USING E-7018 ELECTRODES. WELDING TECHNIQUE FOR THIS MATERIAL IS OF PARAMOUNT IMPORTANCE. ALL SUCH WORK MAY BE PERFORMED BY WELDERS CERTIFIED BY THE AMERICAN WELDING SOCIETY FOR THE POSITION WELDED.

8. SHOP DRAWINGS FOR THIS WORK SHALL BE SUBMITTED TO HARRIS SCIENTIFIC CORPORATION AND BY SAID CO. EXTRA FOR REVIEW AND CORRECTION PRIOR TO FABRICATION.

9. ALL WORK TO BE SUBJECT TO INSPECTION IN THE SHOP AS TO THE EXTENT OF BY SAID CO. OR THEIR AUTHORIZED REPRESENTATIVE.

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ABBREVIATIONS

W.F.	WORKING SCIENTIFIC CORP
S.S.C.	STRUCTURAL STEEL CONTRACTOR
S.S.	STAINLESS STEEL

PREPARED BY:

disalvo+cetra

CONSULTING ENGINEERS

[illegible] MAIN STREET, BRIDGEPORT, CONNECTICUT 06877

TEL: 203-[illegible]

ENGINEER R.D.D. | JOB NO 78-81

NORTH: NOT APPLICABLE | SCALE:

NO.	REVISION	BY	DATE	APP. DATE

SOLAR SUPPORT SYSTEM
1011 HIGH RIDGE ROAD
STAMFORD, CONNECTICUT

PLAN AND DETAILS

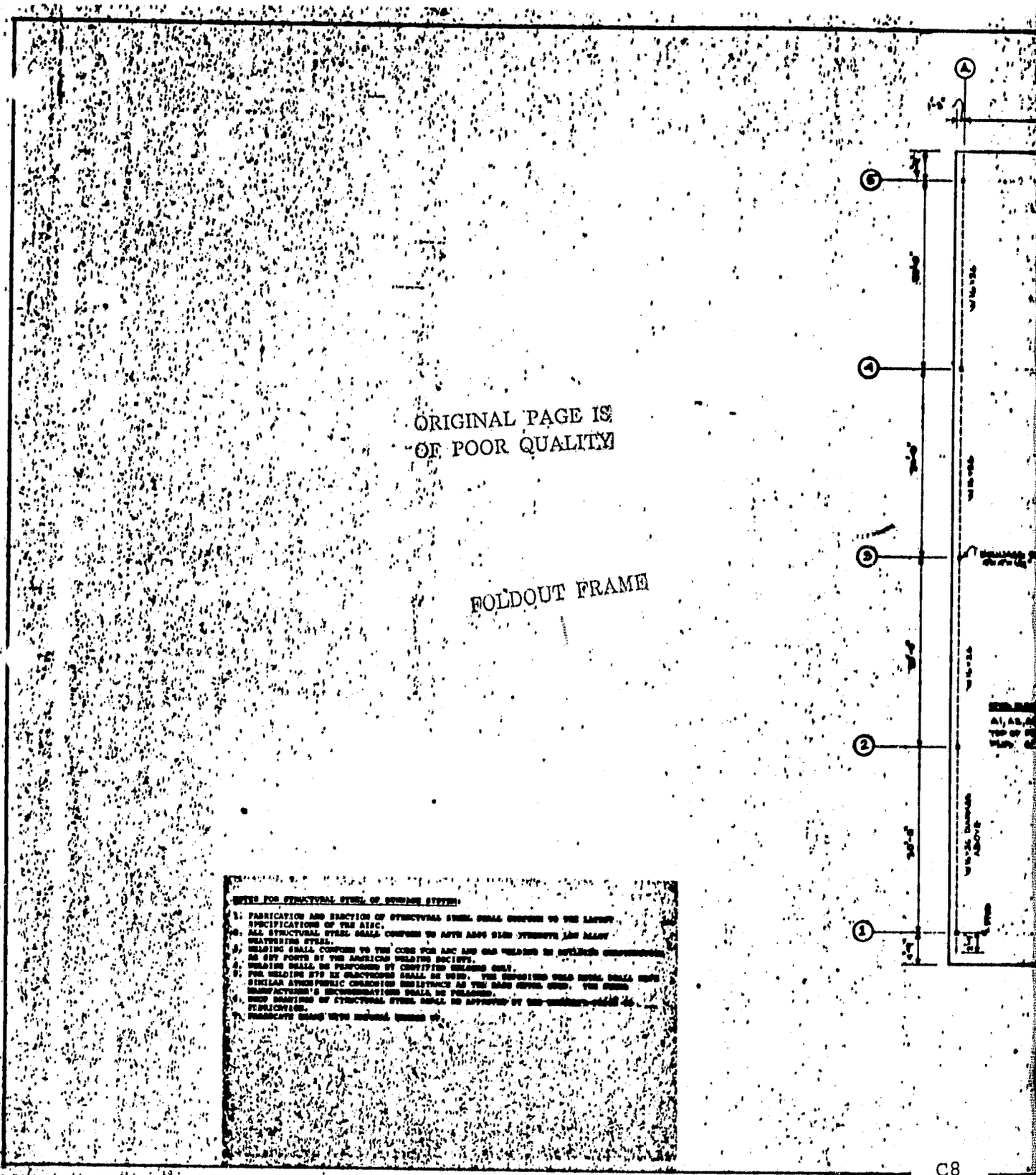
DRAWN BY: F.C.

DATE: 9-[illegible]-77

SCALE: AS NOTED

DRAWING NO. S-1

C7



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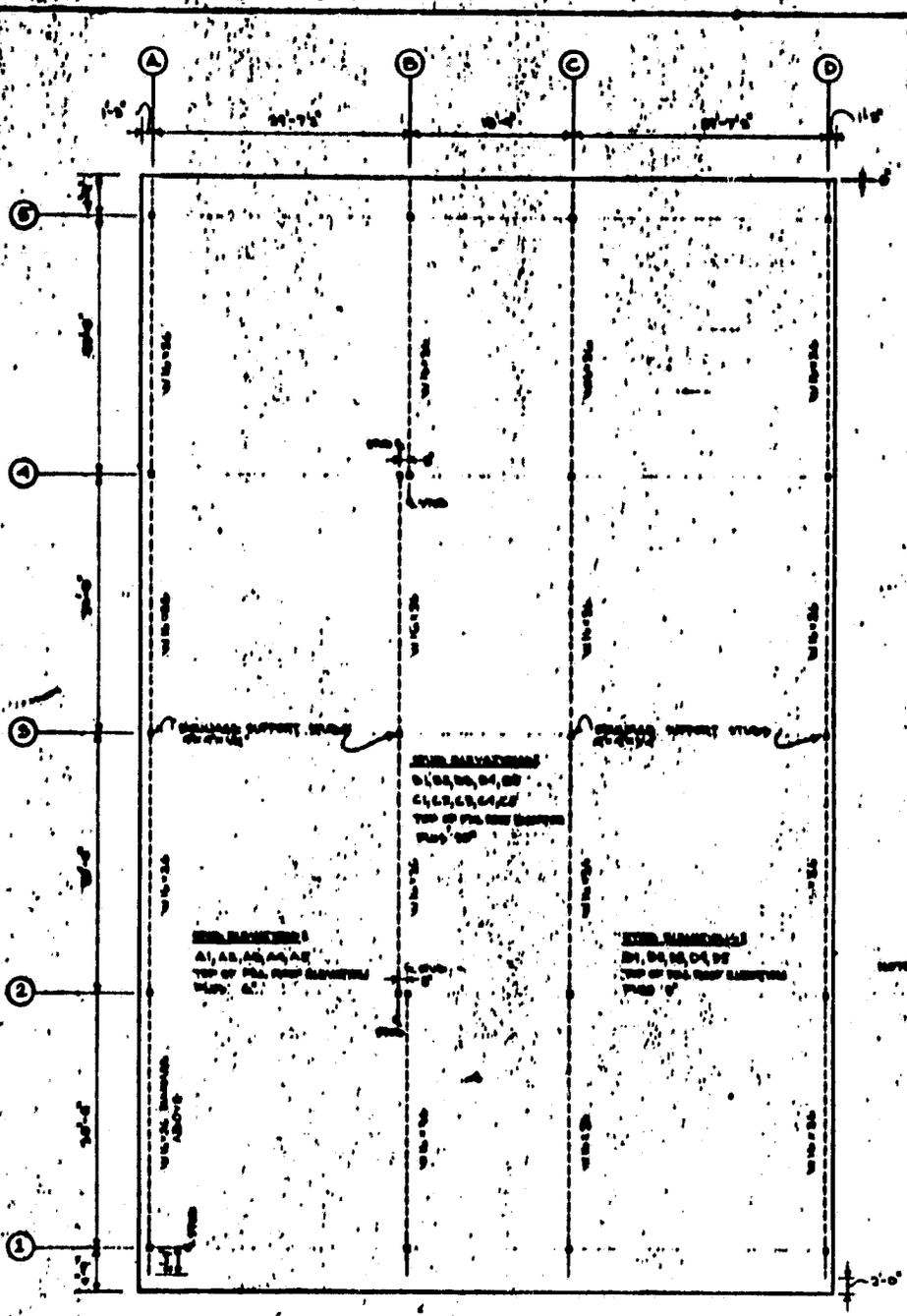

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DUNNAGE SUPPORT STUD PLAN

EXECUTIVE EAST OFFICE BUILDING
WORMSER SCIENTIFIC CORP.
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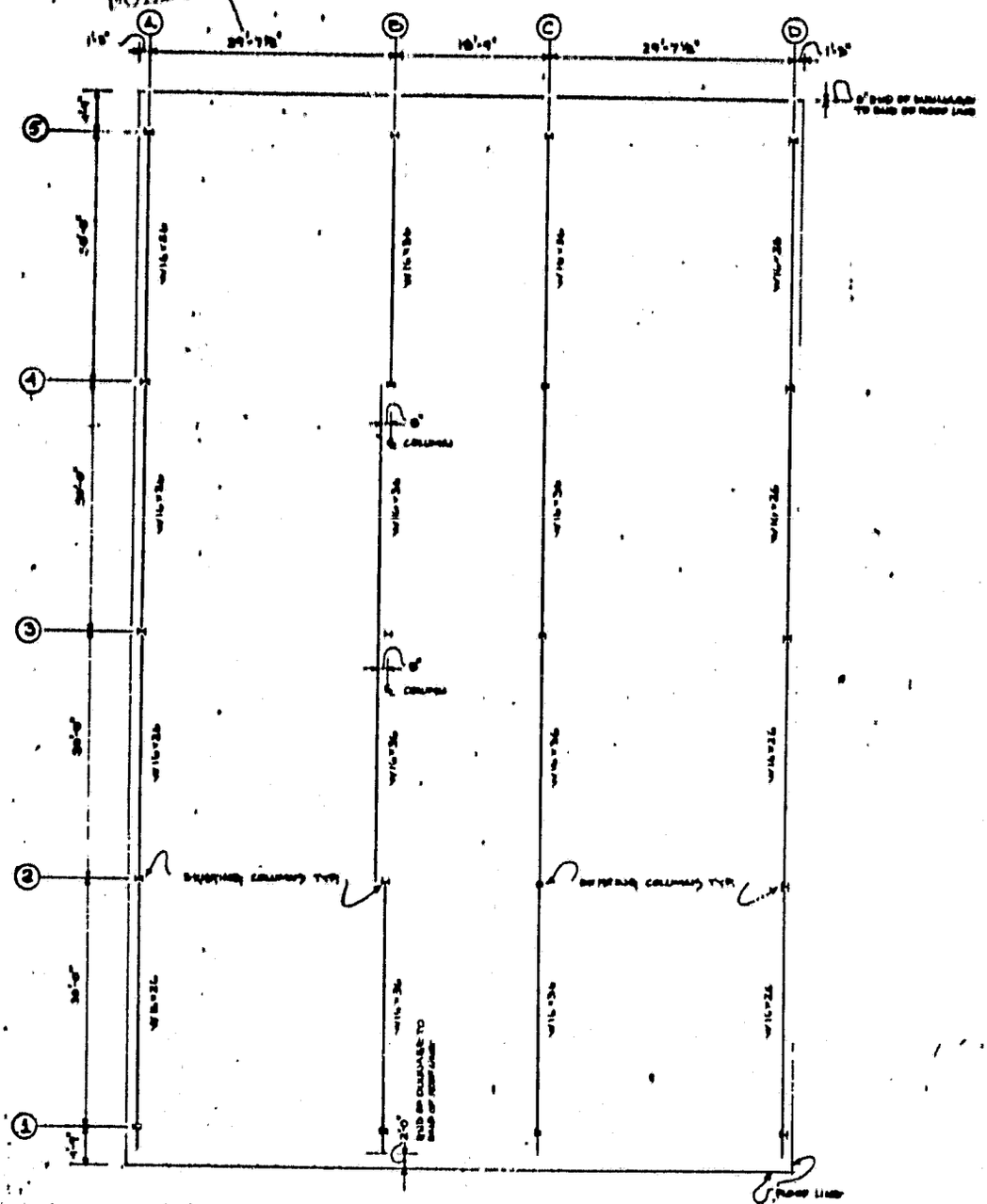
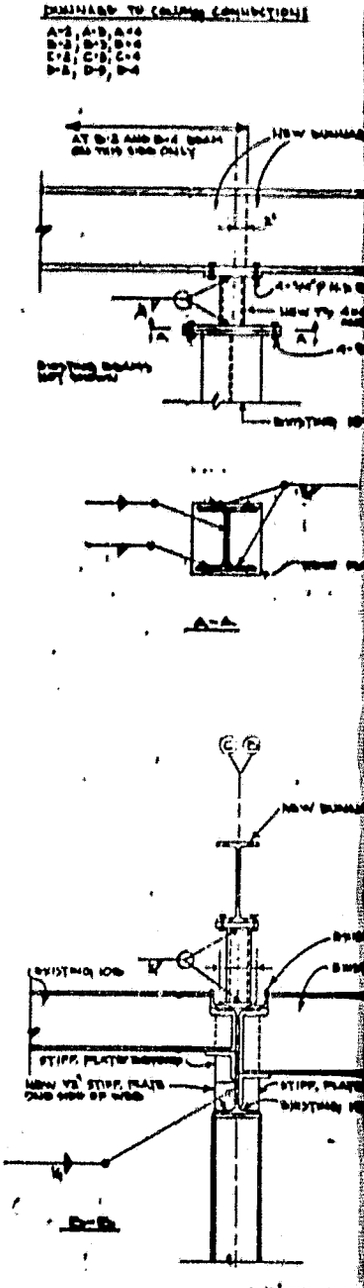
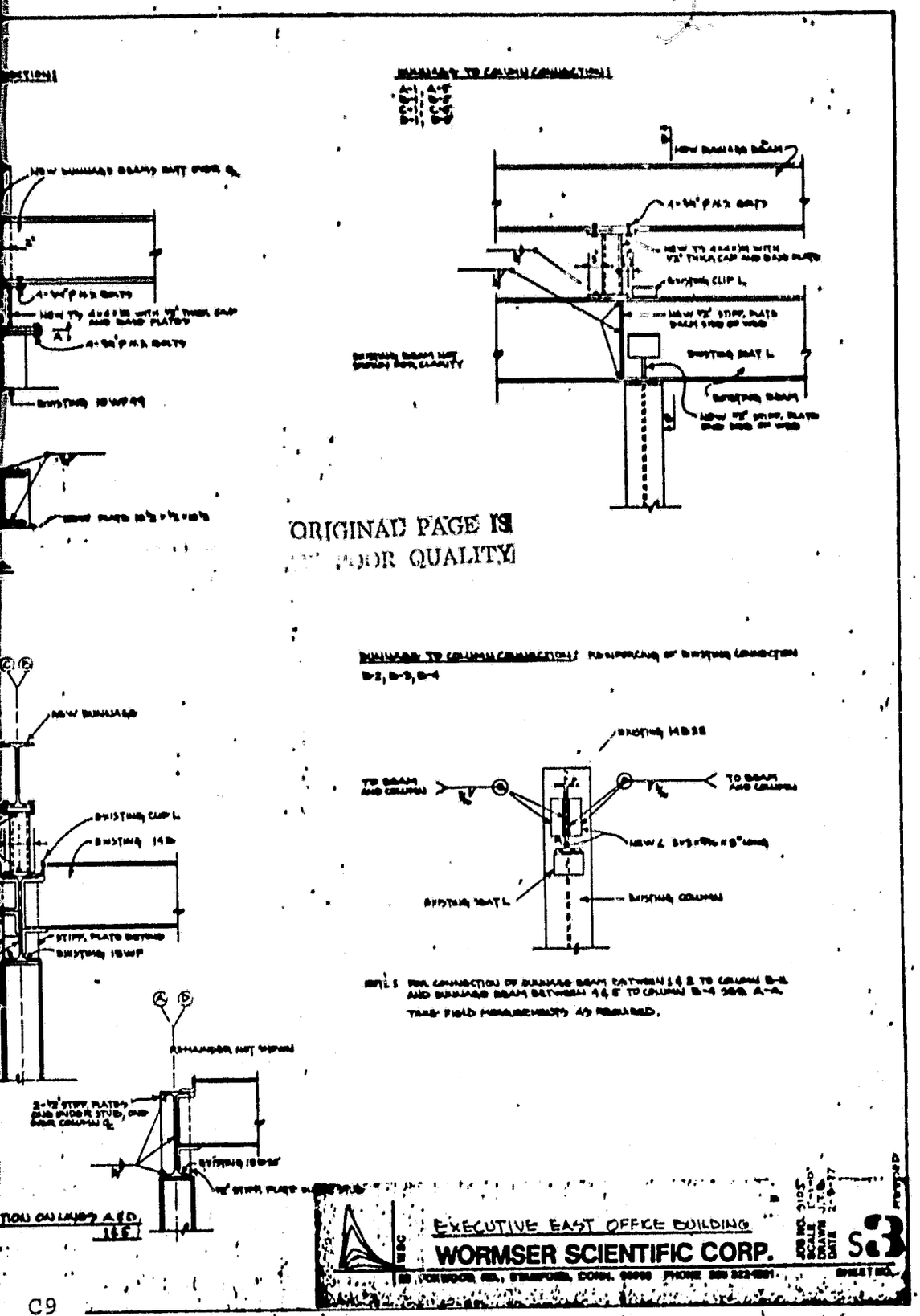


ROOF TOP DUNNAGE PLAN
SCALE 1/8"-1'-0"





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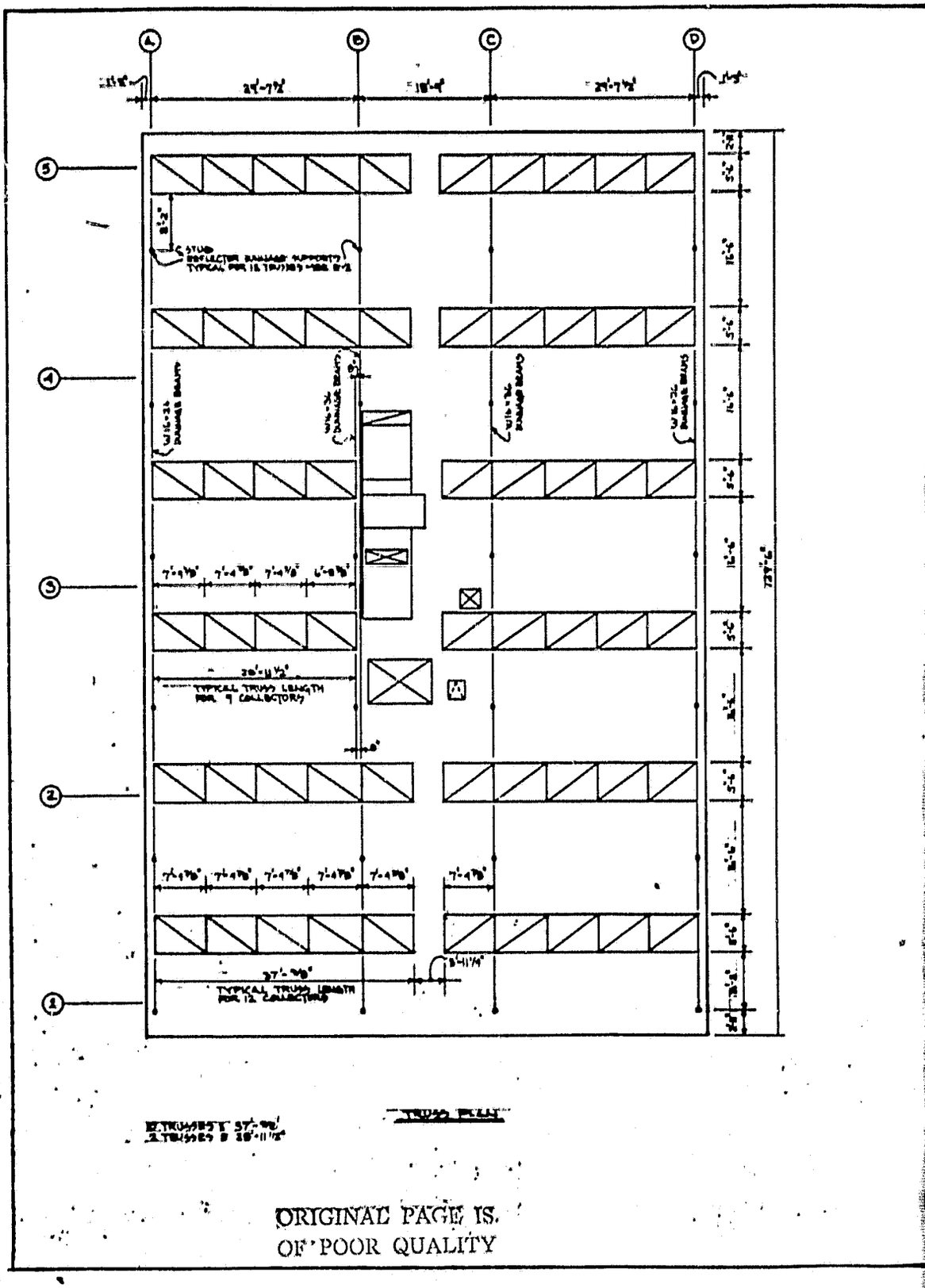
EXECUTIVE EAST OFFICE BUILDING
WORMSER SCIENTIFIC CORP.



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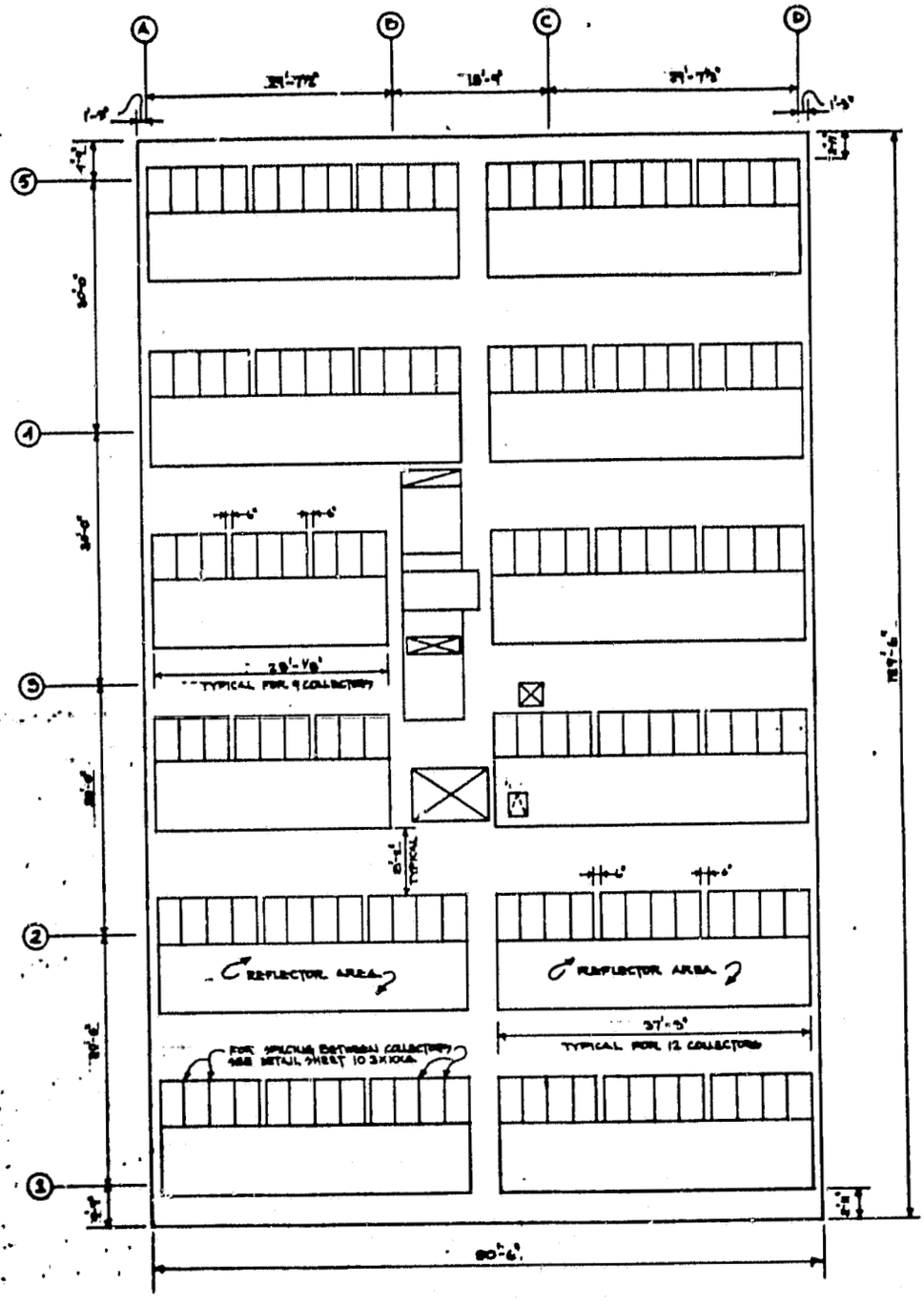
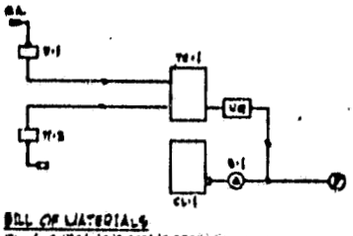


COLLECTOR REFLECTOR PLAN

EXECUTIVE EAST OFFICE BUILDING

WORMSER SCIENTIFIC CORP.

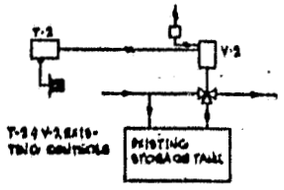


BILL OF MATERIALS

CL-1 C-1761 TIME SWITCH RESERVE CLOCK
TC-1 TC-4100 DUAL BRIDGE CONTROLLER
MS MS-4500 1-STAGE STEP CONTROL SWITCH
S-1 ON-OFF AUTO. SWITCH
TT-1 TS-1500 O.A. TEMP. SENSOR
TT-2 TS-1500 DISCH. H.W. TEMP. SENSOR

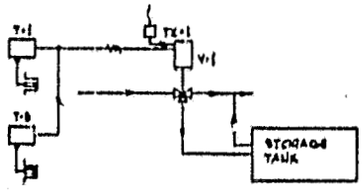
ELECTRIC BOILER CONTROL

NOT TO SCALE



EXIST. CONTROL FROM H.W. STORAGE TANK

NOT TO SCALE



BILL OF MATERIAL

T-1 A20ABA-3 60°F TO 140°F CONTROLLER SET 80°F
T-2 A20ABA-2 10°F TO 90°F LOW LIMIT SET 70°F
TX-1 W6AR-1 120/24 VAC TRANSFORMER
V-1 V9GCA-9 4" 3-WAY DIVERTING VALVE INCLUDES:
M60J0A-1 PROPORTIONAL ACTUATOR
Y20AAB-3 LINKAGE

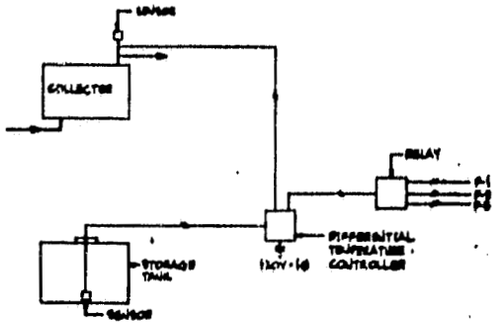
SOLAR STORAGE TANK DIVERTING VALVE CONTROL

NOT TO SCALE

PANEL

VOLTAGE 115/208V 3Ø 4W
TYPE LOAD CENTER
ENCLOSURE SURFACE
MAIN AMPS 100
MAIN C.B. —
SUPPLIED FROM SWITCHBOARD
FEEDER SIZE 4#6, 1"C.

CIRCUIT	TRIP	POLES	FRAME	WIRE	CONDUIT	LOAD KVA	LOAD HP	LOAD SERVED	REMARKS
1		1		#12	3/4		½	P-1	
2		1		#12	3/4		½	P-2	
3		1		#12	3/4		1½	P-3	
4		2						SPARE	
5									
6									
7									
8									
9									
10									



SOLAR ARRAY CONTROL

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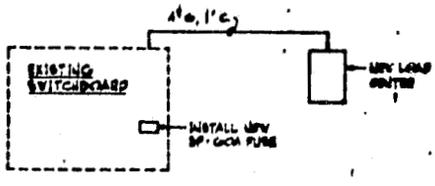

ELECTRIC RISER DIAGRAM

NOT TO SCALE

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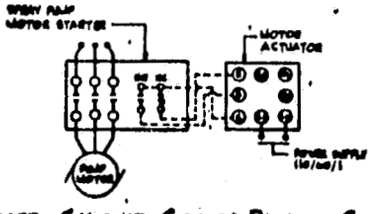

CLOSED CIRCUIT COOLER DAMPER CONTROL

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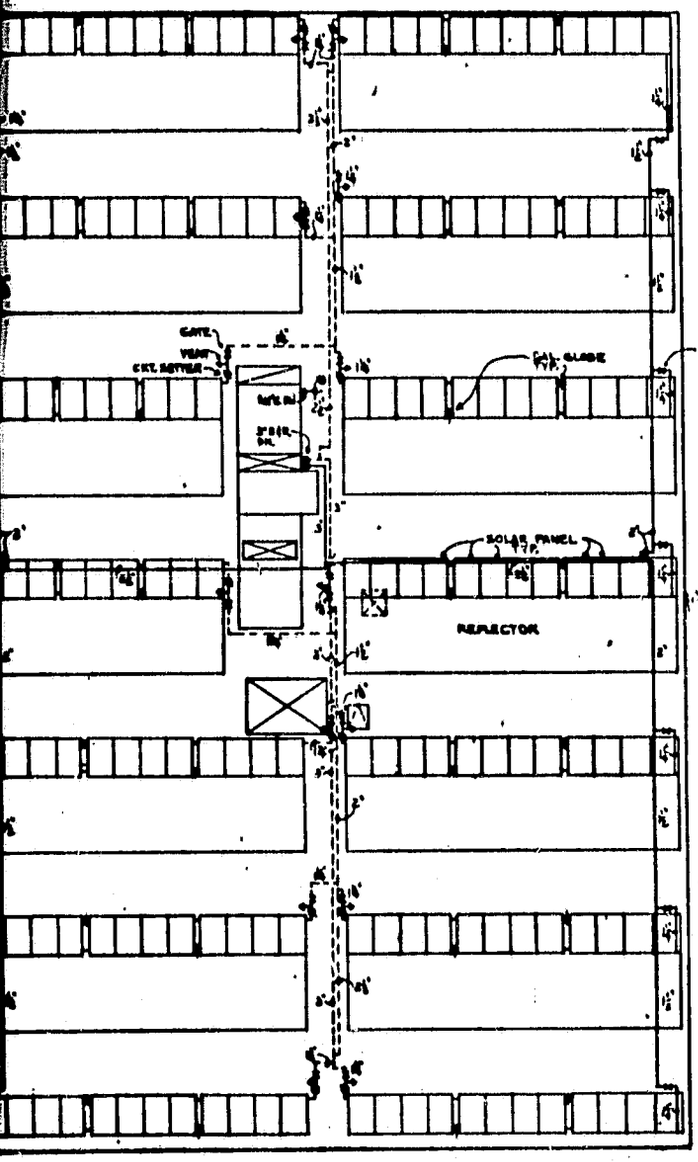

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Sanford O. Hess and Associates
Consulting Engineers, P.C.

ROOF PLAN PANEL LAYOUT
EXECUTIVE EAST OFFICE BUILDING

WORMSER SCIENTIFIC CORP.

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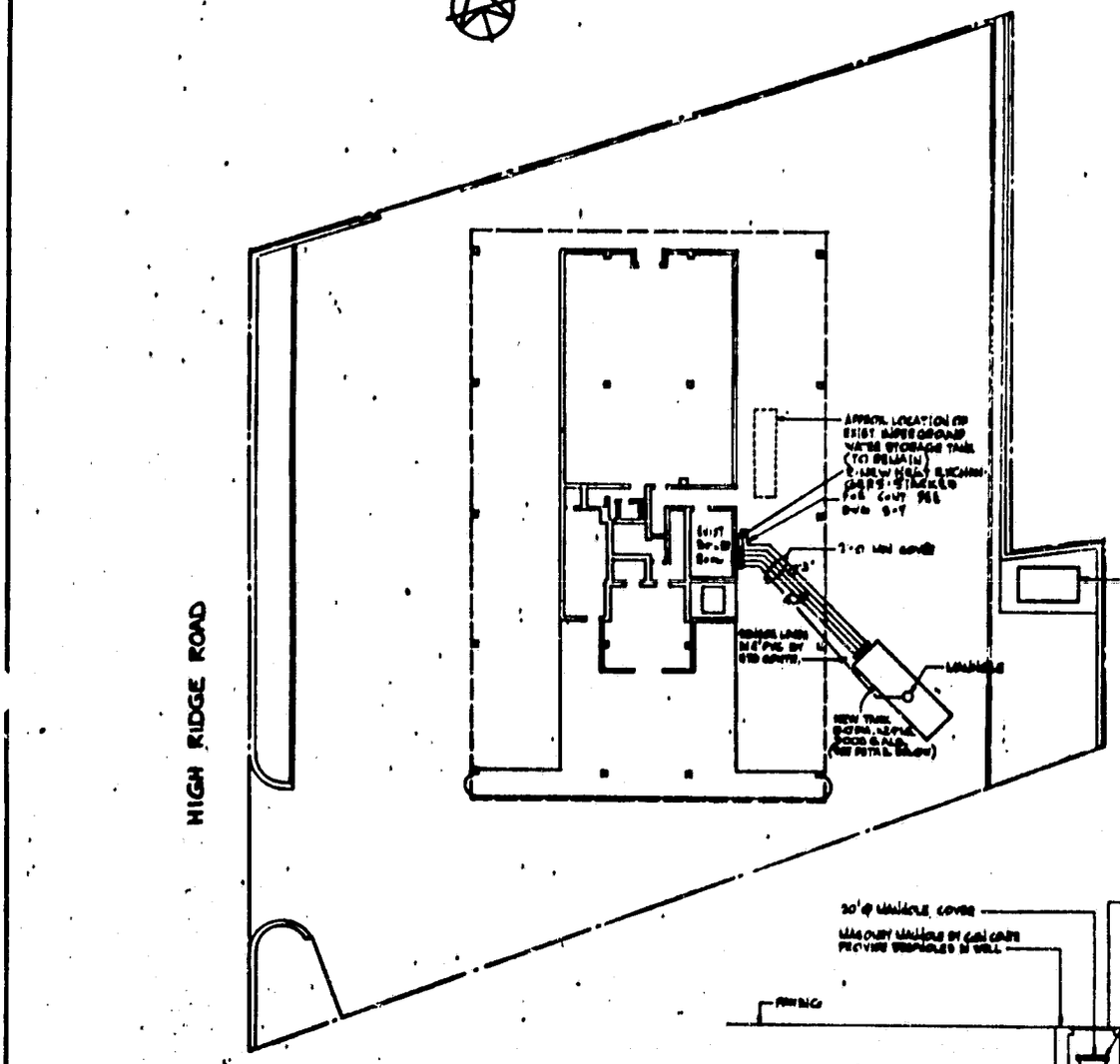
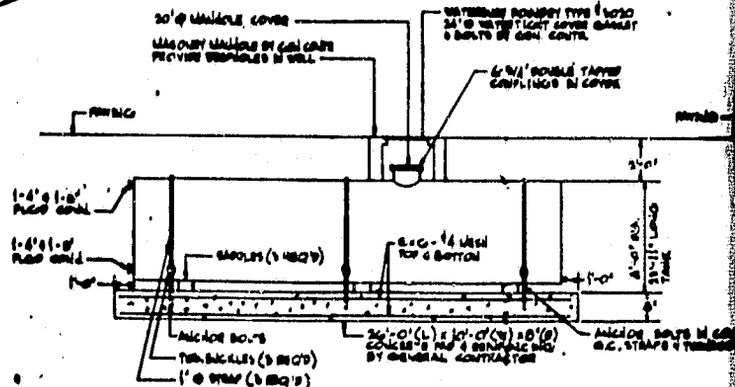
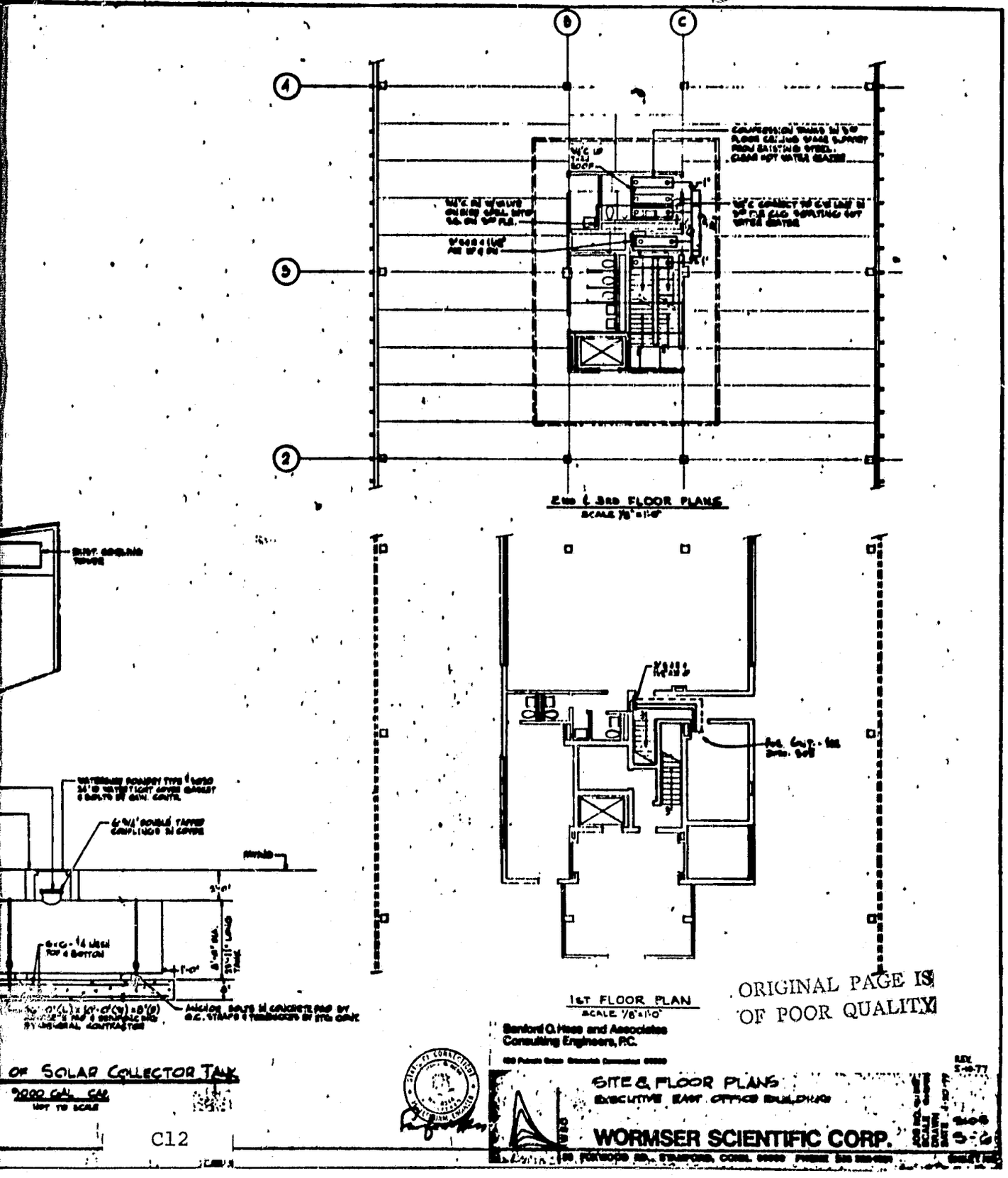


SITE PLAN
SCALE 1"=10'-0"



ELEVATION OF SOLAR COLLECTOR TANK
9000 GAL GAS
NOT TO SCALE

FOLDOUT FRAME



OF SOLAR COLLECTOR TANK

2000 GAL. CAP.

NOT TO SCALE

ORIGINAL PAGE IS
OF POOR QUALITY

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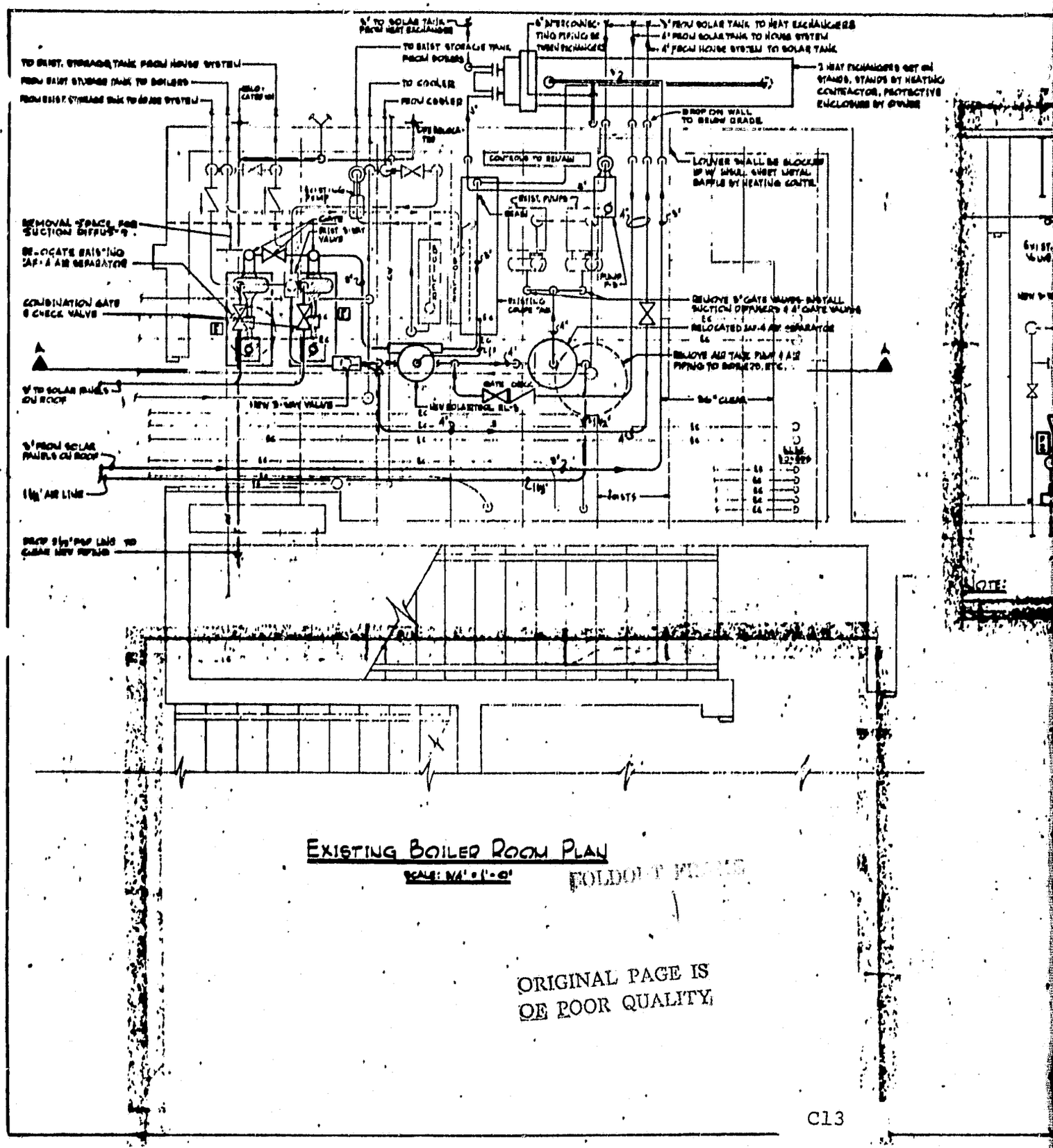
SITE & FLOOR PLANS
EXECUTIVE EAST OFFICE BUILDING

WORMSER SCIENTIFIC CORP.

C12



EXISTING BOILER ROOM PLAN

SCALE: 1/4" = 1'-0"

FOLDOUT FRAME

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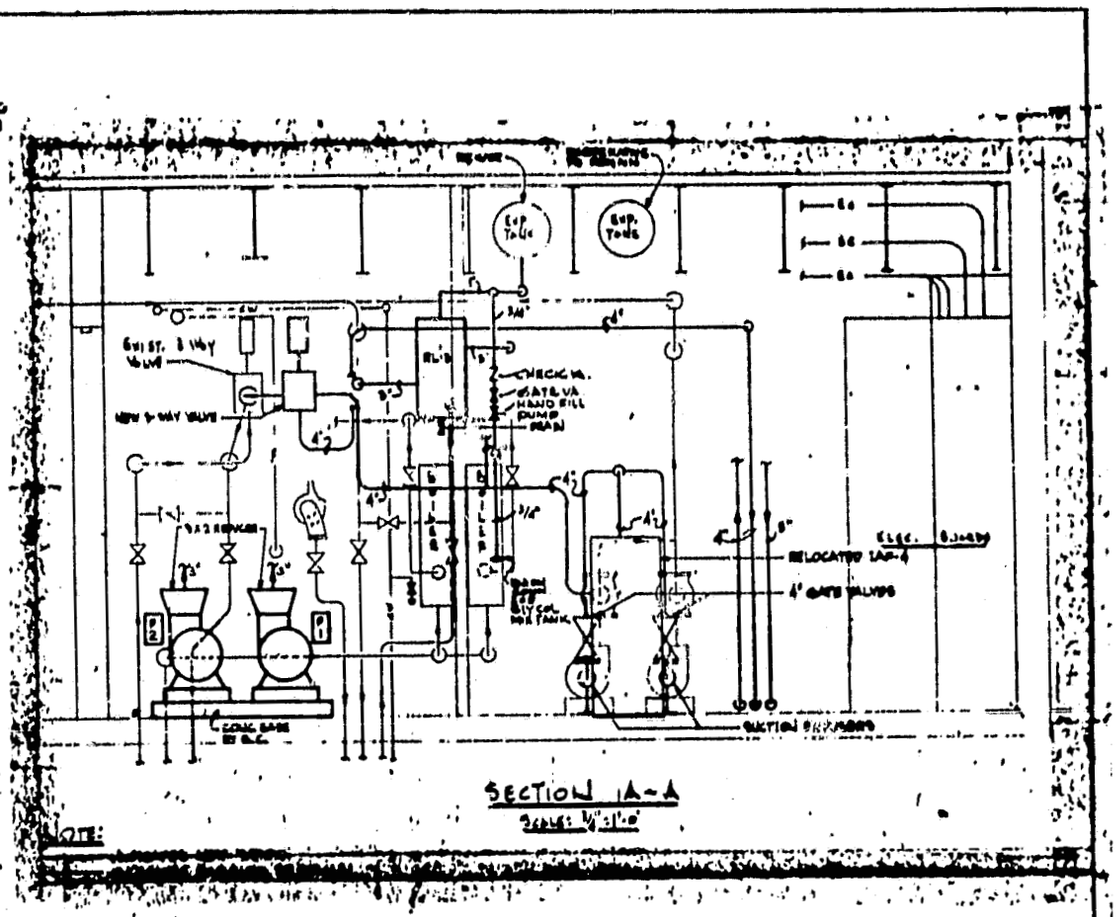
OF POOR QUALITY



SECTION 1A-A

SCALE: 1/4"=1'-0"

FOLDOUT FRAME

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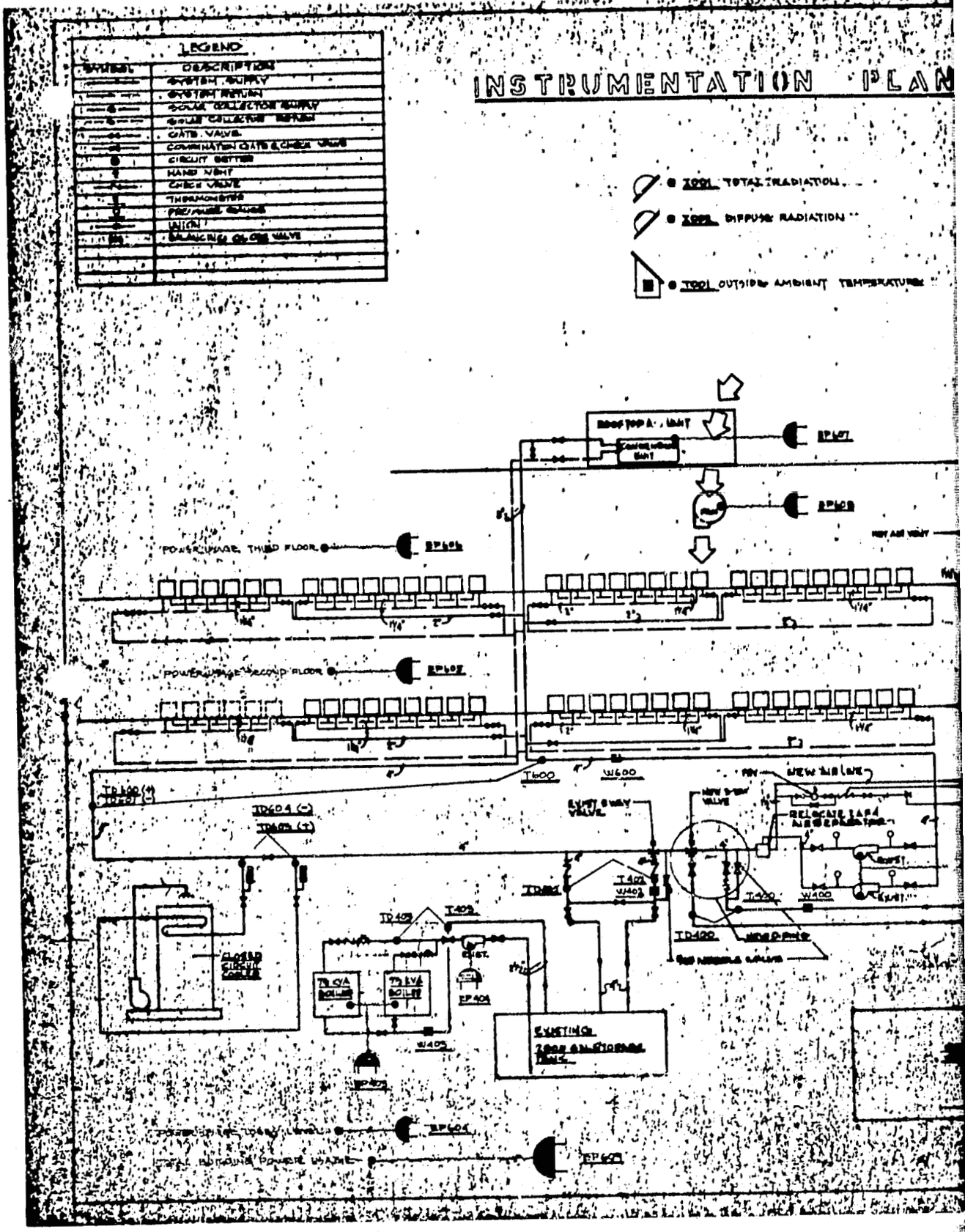
EXISTING BOILER ROOM
EXECUTIVE EAST OFFICE BUILDING

WORMSER SCIENTIFIC CORP.



FOLDOUT FRAME 2

ORIGINAL PAGE IS OF POOR QUALITY